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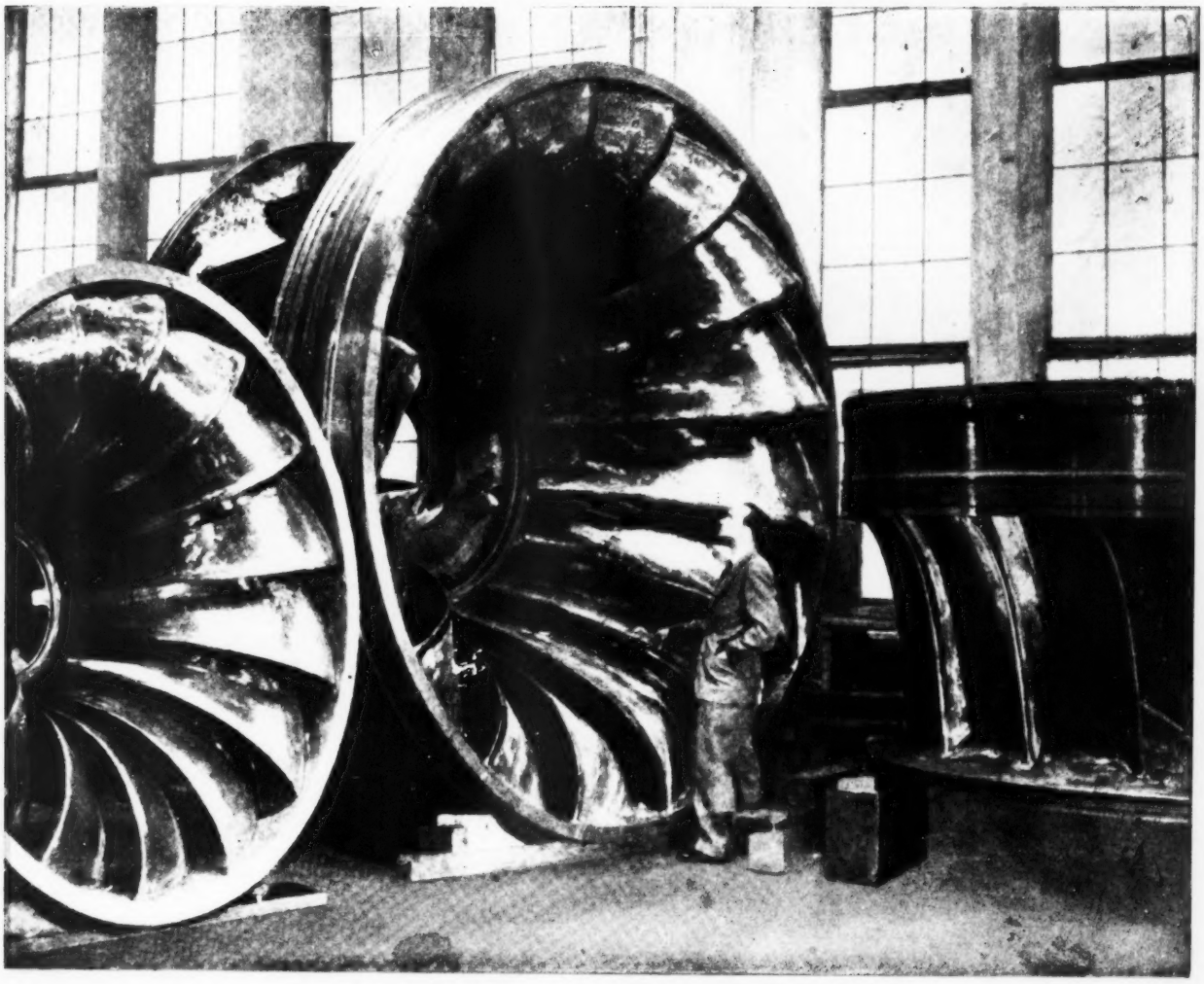
VOL. VI. NO. 6 JUNE 1956 RUPEES TWO



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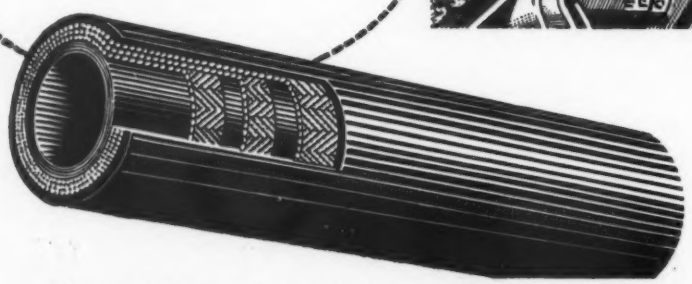

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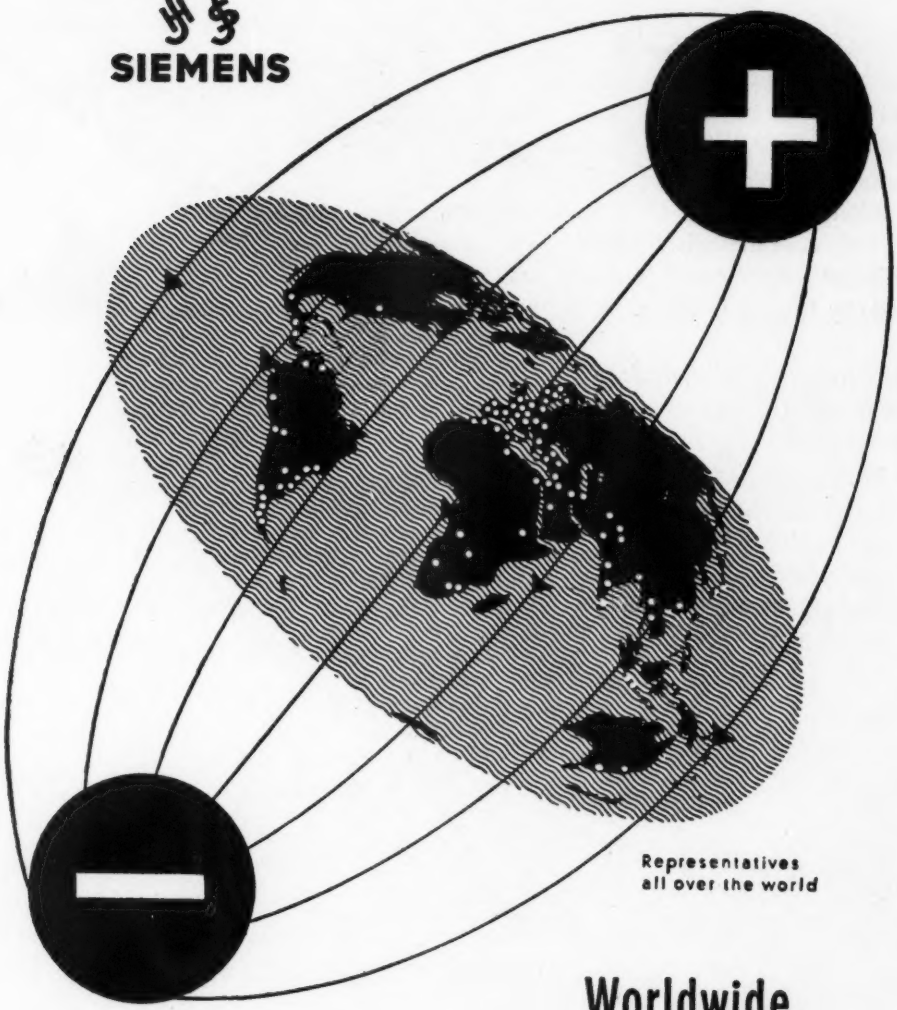

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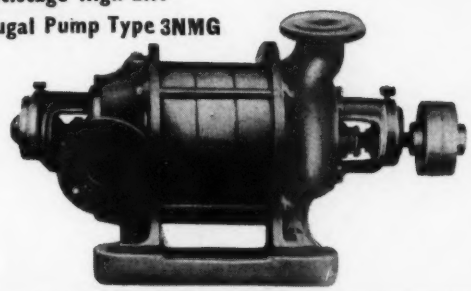

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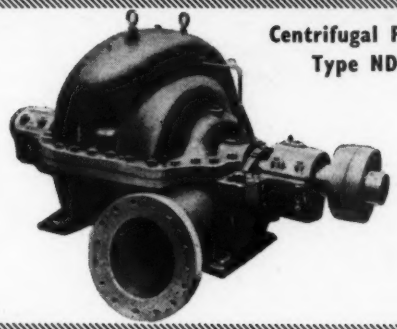
Type NDN



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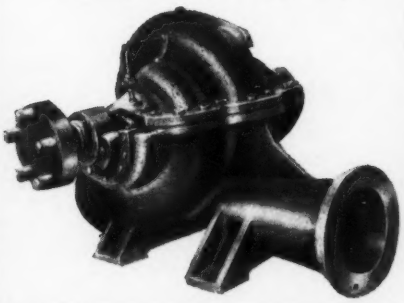

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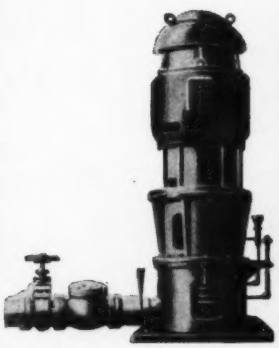

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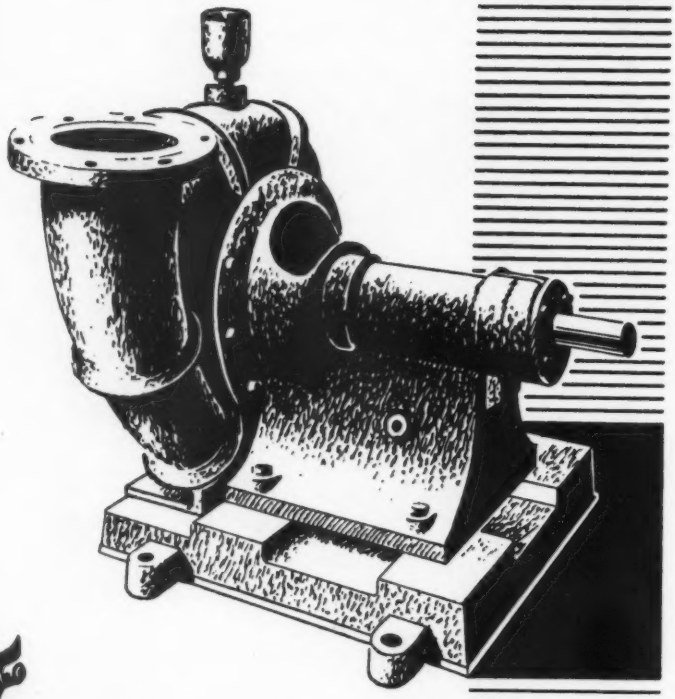

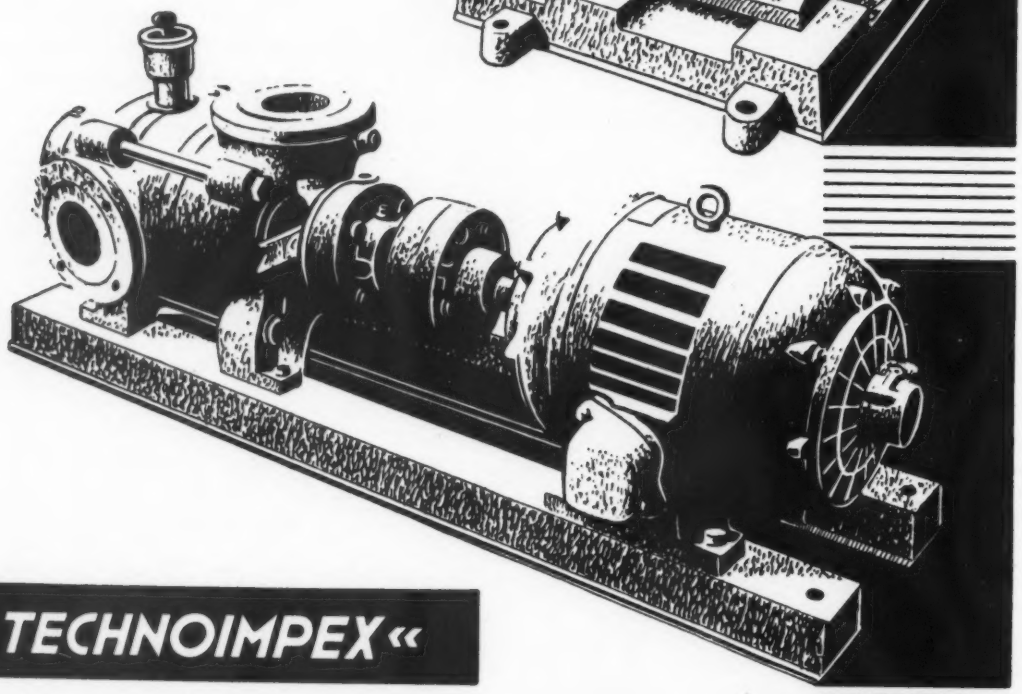

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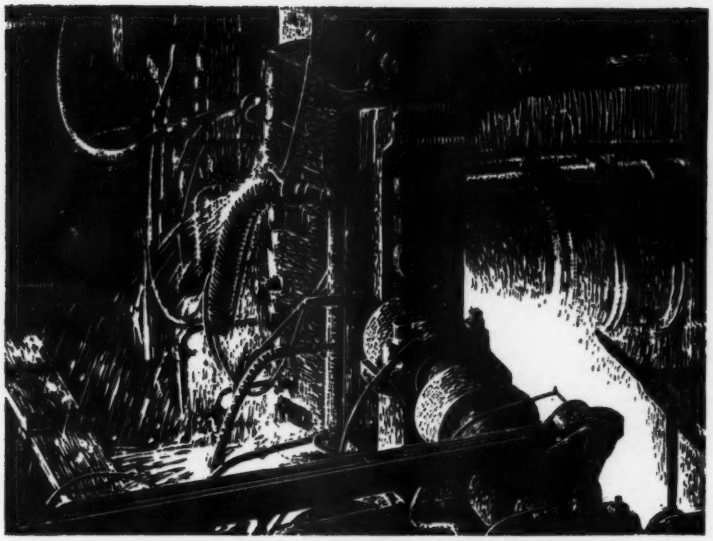

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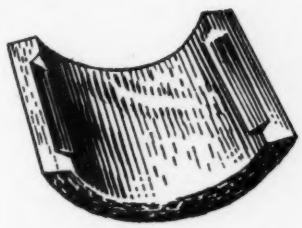

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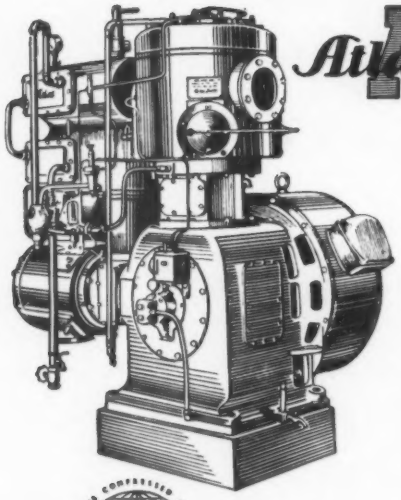

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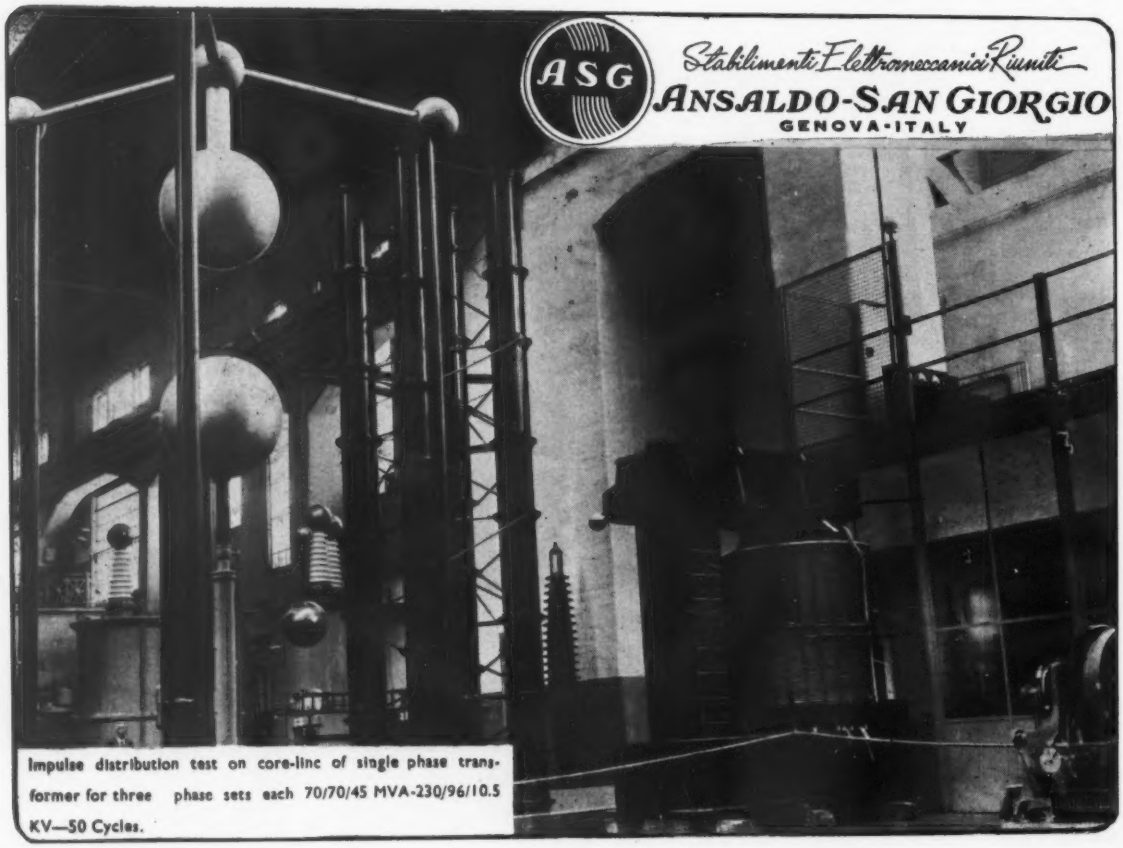

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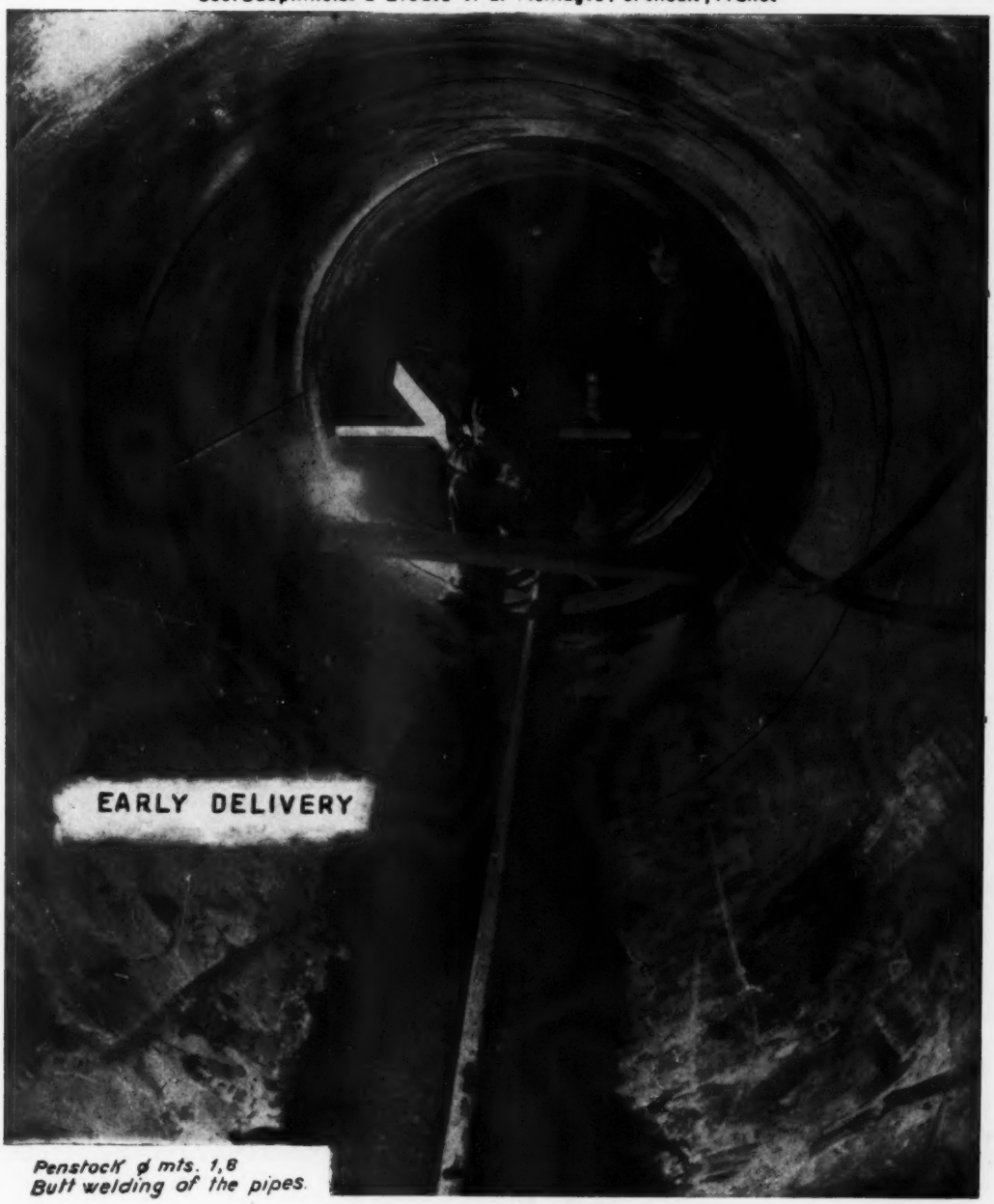

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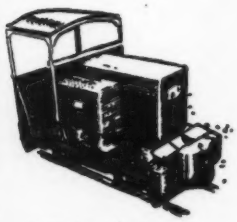

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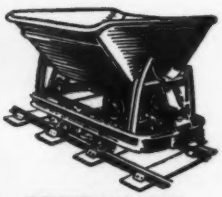

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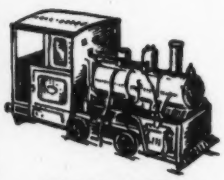

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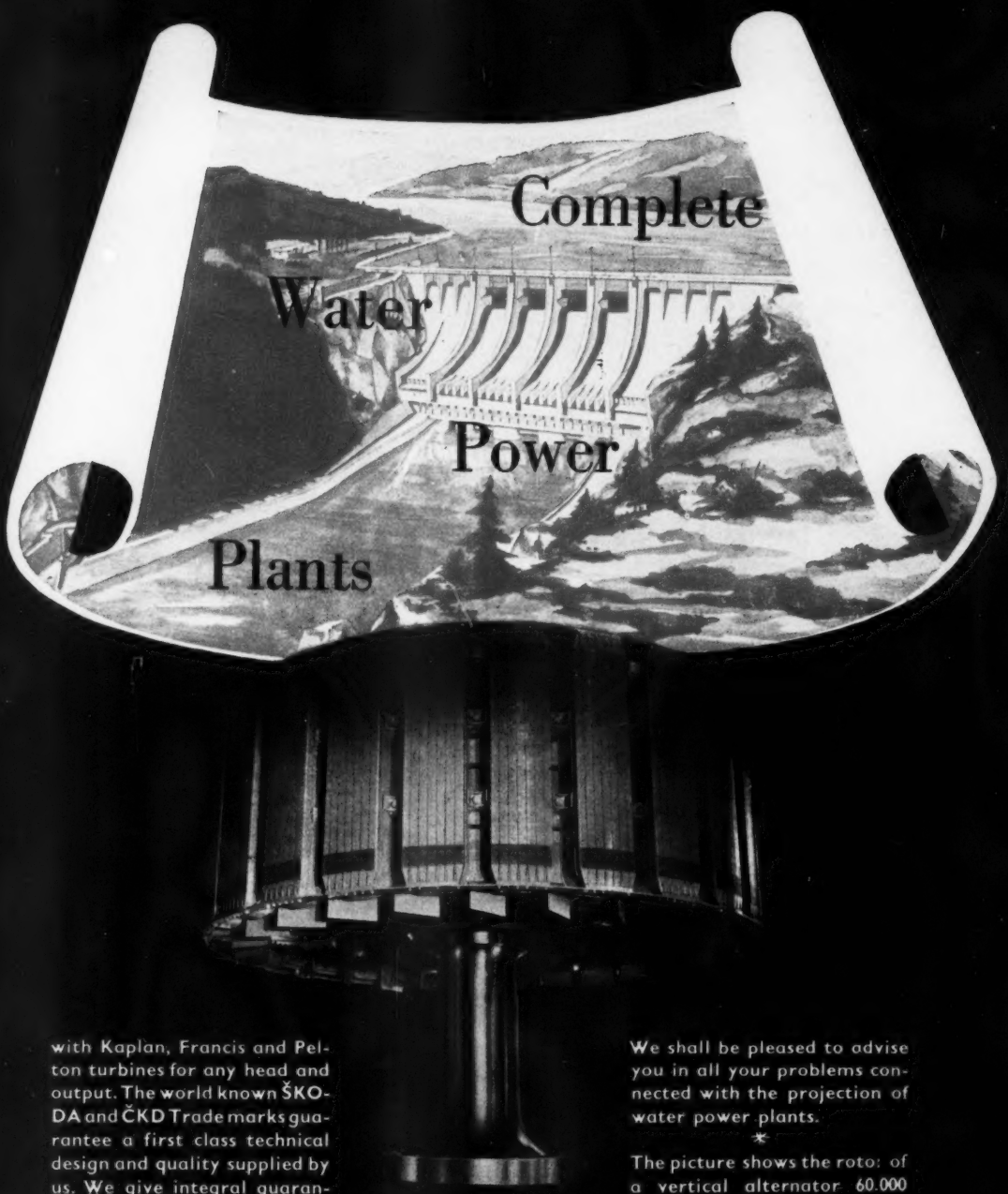

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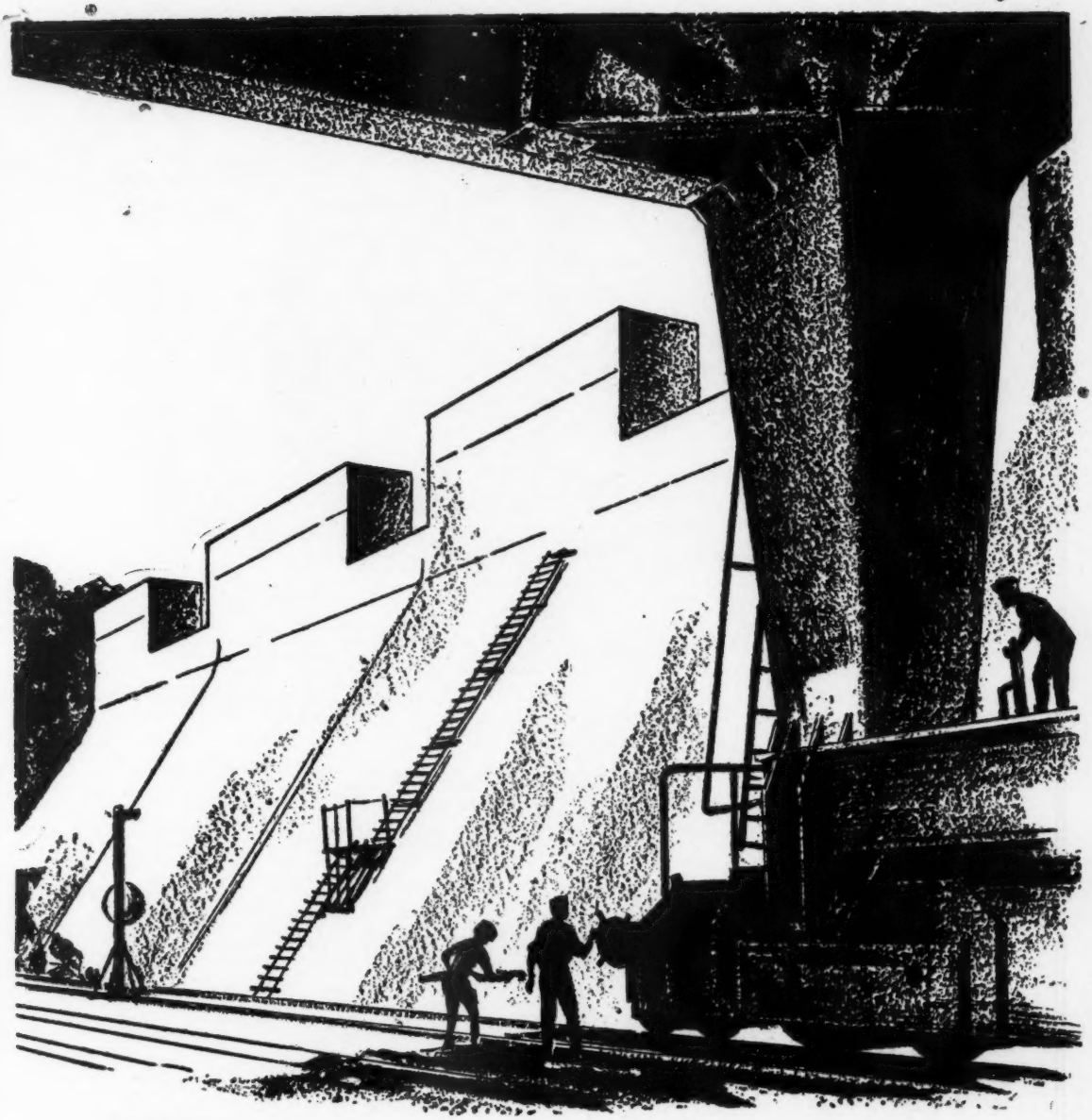

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Vol. VI **June, 1956** **No. 6**

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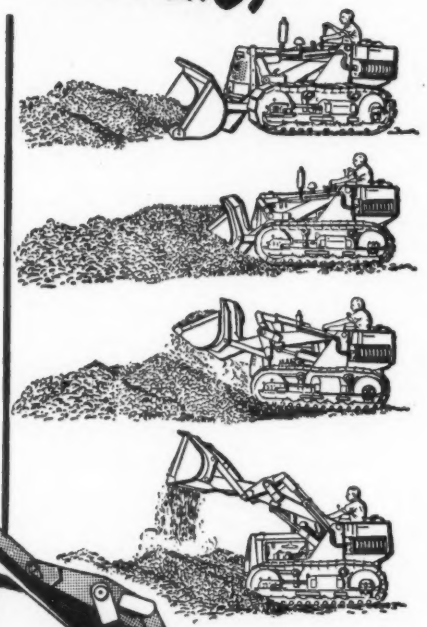

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The Kosi: Bihar's "River of Sorrow"

AUTHOR

By

MADAN BEHARY SAHAY

Kosi Projects Adminisrtation

The Kosi, one of the most ancient rivers of India known as Kausikia in Sanskrit literature, rises in Tibet at about 18,000 feet and joins the Ganga near Kursela after a run of about 450 miles. The river, called the "Sorrow" of North Bihar, has many uncommon characteristics and presents some very difficult problems in its control. At its debouch into the plains at Chhatra ; it is the third biggest of the Himalayan rivers, next only to the Indus and the Brahamputra. Its catchment is about 23,000 square miles of which 2,200 square miles is perpetually under snow. It drains the world's highest peaks, Mount Everest and Kinchinjunga.

A perennial stream

The Kosi is a perennial stream. Its minimum discharge in the winter is of the order of 10,000 cusecs. The highest flood recorded is 8½ lakh cusecs of water in 1954. Its main tributaries are the Sun Kosi from the west, the Arun Kosi from the north and the Tamur Kosi from the east. The entire Tibetan trough from Gosanathein to Kinchinjunga is drained by Arun—the longest tributary of the Kosi—which comes through a gorge in the great Himalayan range. They all join together at Tribeni, about three miles above Barahkshetra, and the joint stream, Sapt Kosi as it is called, flows through a gorge in the Himalayan foothills for about six miles till it emerges into the plains of Nepal Terai at Chhatra.

Main causes of trouble

The Kosi is well known for its vagaries. Rivers may change their courses slightly but this river is very notorious in this respect. Within the last 150 years, it has moved in stages about 70 miles westwards devastating thousands of miles of fertile lands and developed habitation both in Nepal and North Bihar. It carries an enormous silt load. The main causes of the trouble are the river's uncontrolled volume of water which flows through the flat and alluvial terrain of North Bihar, and the annual floods which carry with them large quantities of highly destructive coarse sand and detritus which get deposited in the bed and force the river to change its course. The silt deposits transform fertile lands into waste lands and orchards into a mass of wood. Thus the amount of human suffering and the instability of life caused is immense. The annual loss in terms of money is estimated at 6 to 10 crores of rupees.

Past attempts

The shifting of the course of the Kosi and its silt problem has received considerable notice. At a Calcutta conference held in 1896-97 it was concluded that no steps for controlling the course of this big river were feasible except by ad-hoc protection by short lengths of embankments. Again a conference of officials and non-officials was called in 1937 by the Provincial Government to discuss this very difficult and pressing problem of floods in the Kosi and in North Bihar. The deliberations of this conference do not appear to have led to any protective results. Sir Claude Inglis, the then Director of the Central Irrigation and Hydrodynamic Research Station, India, who visited the Kosi in 1941 to advise the Nepal and Bihar Governments regarding the Kosi problem felt that the main cause of the shifting of the river was the excessive presence of coarse silt the water carries. He wanted some more data to be collected for the lower reaches of the river but no action was taken on his report.

The two dam projects

Lord Wavell, the then Viceroy and Governor-General of India, visited the Kosi flood affected areas in 1945. He was deeply moved by the immense destruction of valuable land and the enormous human suffering caused by the vagaries of the "River of Sorrow". At his instance, a comprehensive invesitgation was taken up by the Central Water Irrigation and Navigation Commission in 1946. The first proposal was to construct a dam, about 750 feet high, across the gorge near Barahkshetra for trapping silt and storing water, development of hydro-power at the foot of the dam and barrages, one in Nepal territory and another in Bihar, to control and stabilise the river channel and provide irrigation facilities. Later, in 1950, the dam project was divided into seven stages. The multipurpose project was estimated to cost Rs. 177 crores. The cost of the dam was, however, found to be prohibitive because no use could be found for large quantity of power to be generated in the dam. The completion of work through all the different stages would also take a very long time. Alternative sites were then explored, and an advisory committee of engineers recommended the erection of a low detention dam at Belka in the first instance. It was proposed to construct the dam at the nose of the Belka Hill, nine miles below Chhatra, to impound 1.8 million acre feet of water and taking out three canals for irrigating lands below. Provision was also made for the installation of power plant with an ultimate capacity of 68,000 KW. The scheme was essentially

Women's contribution to the execution of the Kosi Project.
On the western Embankment: Women labourers carry-earth from borrow-prits to the bundh.

aimed at meeting the two pressing needs of silt and flood control. This project too was found to be much more expensive than what was estimated originally, and to contain other defects.

The present plan

So, with the data available, a new scheme was prepared in 1953, by the Central Water and Power Commission. It consists of the following items of work :—

(1) A barrage 4 miles above Hanumannagar. Its length would be about 4 miles of which the concrete portion would be 3,670 feet. The proposed barrage falls in the Nepal territory. Its purpose is to (a) tie the lines of embankment below and above the barrage ; (b) arrest coarse silt and flatten the gradient ; (c) provide for diversion of 75,000 cusecs of flood water into the four old channels of the Kosi on the eastern side ; and (d) provide for irrigation of nearly 14 lakh acres of the Kosi on the eastern side.

(2) To construct two lines of embankment, 70 miles in length on the western side from Bharda to Jhamta, and 60 miles on the eastern side from Bhimnagar to Bangaon.

(3) To construct two afflux bundhs ; (a) One on the western side, about 8 miles long, from Bharda to a point where it meets the ancient Birbundh ; (b) the other on the eastern side, about nine miles long, from Bhimnagar to Kusaha. Beyond the eastern afflux bundh will be constructed a flood bank for a length of about 14 miles till it meets high ground.

(4) To provide diversion channels by resuscitating the four old streams, namely, Dhemra, Tilwa, Parwane and Bhenga in order to take a portion of the flow. The streams have been very active from time to time and they still take some discharge at the time of floods. The purpose of the diversion is to reduce the intensity of flood in the present flow area. Additional irrigation can be arranged from the diversion channels.

(5) A canal system will be taken from Bhimnagar to Araria with four main distributaries named as the Supaul branch, the Pratapganj branch, the Purnea branch and the Araria branch.

Estimate

Originally, 1953, the C.W.P.C. had estimated that the implementation of the scheme might cost Rs. 37.30 crores as detailed below :—

(*a*) Hanumannagar barrage	Rs. 13.27 crores
(*b*) Flood embankments and Protective measures	Rs. 10.67 crores
(*c*) Eastern Kosi canal system	Rs. 13.36 crores
TOTAL	Rs. 37.30 crores.

But this estimate is still under the examination of the State Government and is awaiting sanction.

Work in Progress

Following the decision in November, 1954, to implement the Kosi Project plan as prepared by the Central Water and Power Commission in 1953, the work on the construction of embankments was inaugurated on the 14th January, 1955, by Dr. Srikrishna Sinha, Chief Minister of Bihar. An outstanding feature of the Project has been the utilization of public cooperation in the construction of the embankments.

Work Done

During the last working season (1954-55) the total man-days came to over 40 lakhs ; the total earthwork done was 18 crore cubic feet. The total length of embankments constructed was 54½ miles as detailed below :—

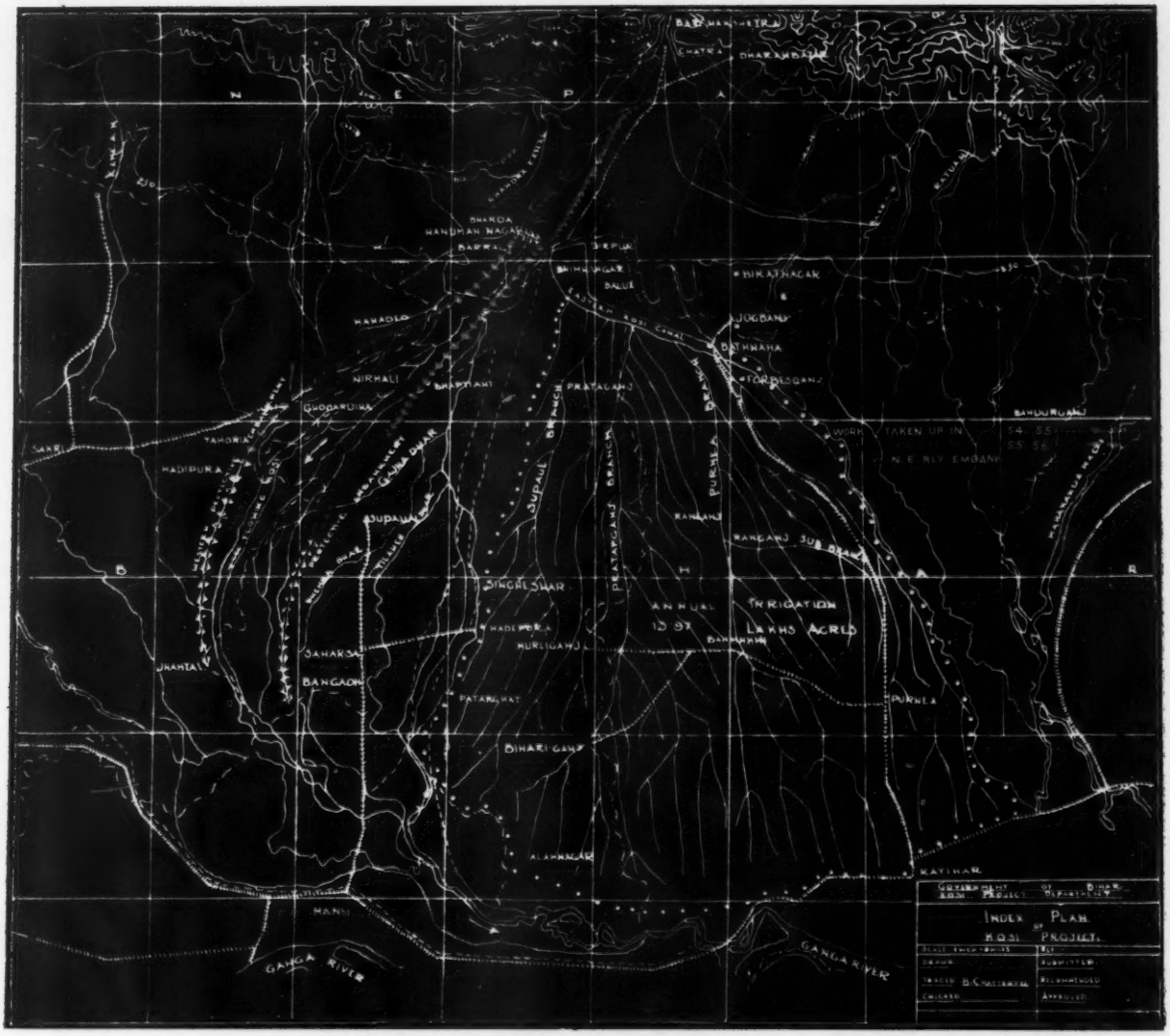
(1) Western Embankment (Nirmali to Kanhauli Bazar including ring bundhs and Tiljuga marginal embankment ..	25½ miles;
(2) Eastern Embankment (Piprakhurd to Therbitta) ..	9 miles;
(3) Eastern Afflux bundh and flood embankment ..	20 miles;
TOTAL	54½ miles.

Programme of work

The programme of work for this season (1955-56) includes the construction of further 60 miles of embankment as given below :—

(1) Western Embankment (Kanhauli Bazar to Bharda) ..	9½ miles;

Kosi Project: Symbol of Indo-Nepalese Friendship.
Nepali labourers at work on this eastern embankment near Baghjora.



Index plan of the Kosi Project

(2) Ghoghardiha to Madhepur including marginal bundh on the Bhutahi Balan. .. 12½ miles;
(3) Eastern Embankment (Below Piprakhurd) .. 9 miles;
(4) Therbitta to Bhimnagar .. 29 miles;

TOTAL 60 miles.

Public Cooperation work

Two Nepal Ex-Servicemen's societies have taken up 9½ mile long embankment from Bharda to Kanhauli Bazar. Local Gram Panchayats of Nepal have also been invited to participate in the work.

The Bharat Sevak Samaj have taken up for work through public cooperation a total length of about 21 miles as shown below :—

(*a*) Western Embankment (Ghoghardiha to Madhepur and the marginal bundh on the Bhutahi Balan) .. .. 11 miles;
(*b*) Eastern Embankment (Below Pipra khurd) .. 9 miles
(*c*) Above Therbitta .. .. 1 miles

TOTAL 21 miles.

Others works

Other programme of work in this season (1955-56) includes further preliminary work for the construction of the barrage, completion of the access road from Bathnaha to Bhimnagar and Birpur, the construction of a narrow gauge railway line of the Project from Bathnaha to Bhimnagar, Chhatra and Dharna Bazar (about 66 miles) and the construction of staff colonies at Birpur, Bathnaha, Dharan Bazar, Bhimnagar and Supaul.

Soil conservation

The chief trouble in the Kosi is that it carries a lot of sediments from the Himalayas and deposits them in the plains. This causes the river to shift from place to place. Investigations are therefore in progress

A panoramic view of labourer at work near Rajpur—a long reach between Bhimnagar and Therbitta.

to prevent large-scale soil erosion in the Himalayas. This will incidentally keep up the green appearance of the beautiful mountain. Preliminary soil conservation works are being carried out in the mounainous region. Here too a large number of Nepali labourers are working with enthusiasm.

Progress of work

During the current season 41 crore cubic feet of earthwork is to be laid on the embankments. In spite of delayed start in some reaches due to water-logging and other procedural difficulties, 22 crore cubic feet of earthwork was done by the end of March, 1956. 1956. The Bharat Sevak Samaj have completed two-third of the allotted work.

High Labour Attendance

The response in public cooperation sector is satisfactory. High labour attendance is due to the popularity of the scheme. At its peak, daily labour attendance on the embankments was 65,000, the daily average in the last three months being 50,000. It is hoped that two-third of the total length of the embankments of 140 miles, as estimated in the Project, may be completed by the middle of June, 1956.

The following chart shows the agency-wise progress on earth-work from January 14, 1955 to the end of March, 1956.

Agency of Execution	*Length of miles*	*Total earth work involved in lakh cft*	*Earthwork done in lakh cft. from start upto March, 1956*
1. Public Cooperation	32	1,458.10	1,068.88
2. Shramdan	½	28.95	18.63
3. Nepal Societies.	10½	323.41	132.30
4. A.C.C. & N.C.C.	1	74.18	40.49
5. Contractors	70½	4 079.29	2,782.80
TOTAL	114½	5,963.93	4,043.10

Barrage

The work on the barrage can commence only after adequate materials are collected at the site, machinery purchased and the construction plant erected. The barrage will be situated 4 miles above Hanumangar in Nepal. Its length would be 4 miles of which the concrete portion would be 3,670 feet.

Salient features at a glance

The Kosi River

1. Catchment area upto the barrage site.	23,858 Sq. miles
2. Maximum flood discharge	9,50,000 cusecs.
3. Minimum discharge	10,310 cusecs.
4. Maximum flow observed	8,60,000 cusecs.
5. Mean annual run off	43m. acre feet

Cost and Benefits

Investment	*Return*
1. Coal 1.3 lakh tons.	1. Power 20,000 KW
2. Stones, 325 lakh cubic feet.	2. Lands to be saved from floods—20 lakh acres.
3. Cement 1.8 lakh tons.	3. Lands to be irrigated—15 lakh acres.
4. Iron and sheet 27 thousand tons.	
5. Money 42.50 crores of rupees.	
6. Man-power 32,000 per day (during working season the daily labour attendance goes upto 65,000).	

Embankments

1. (*a*) Bharda to Jhamta	70 miles
(*b*) Afflux bundh above the barrage from Bharda to Birbundh	8 miles
2. Eastern Embankment :—	
(*a*) Bhimnagar to Bangao	60 miles.
(*b*) Afflux bundh above Bhimnagar upto Kusaha ..	9 miles.
(*c*) Flood bank beyond beyond afflux bundh	14 miles.

The Barrage

(*a*) *Main Barrage* :—	
Designed discharge	8,75,000 cusecs
Length of main Barrage ..	3,190 ft.
Crest level ..	EL 235.00
Roadway level ..	EL 255.00
Gates. ..	30′×22′-6″×86 nos.
(*b*) *Diversion Barrage* :—	
Designed discharge	75,000 cusecs.
Length of Diversion Barrage ..	474 ft.
Crest level I) under sluice	EL 230,00
II) silt excluder	EL 235.00
Roadway level	EL 255.00
Gates ..	13′×22′-6″-12 nos
Total volume of concrete :—120 lakh cft.	

Earth Dam

Eastern portion	11,436 ft.
Central portion	1,000 ft.
Western portion	12,000 ft.
Top of Earthdam	EL 265.00

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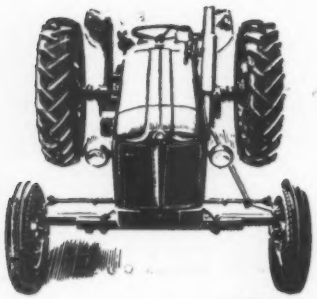

Logging
Levelling
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Loading
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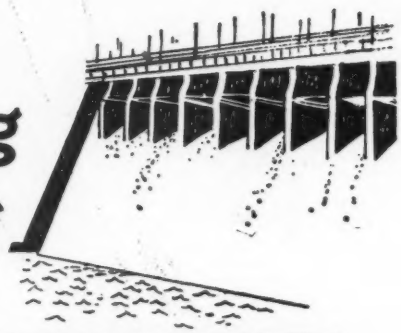
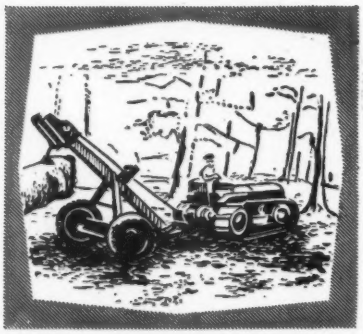
Hole digging





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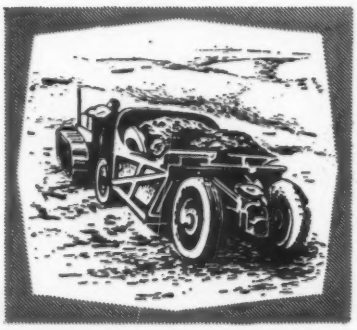

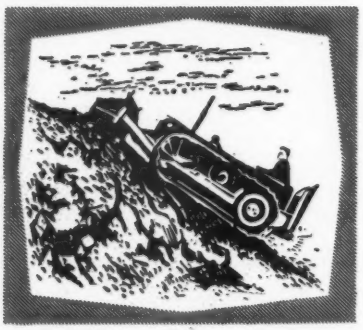

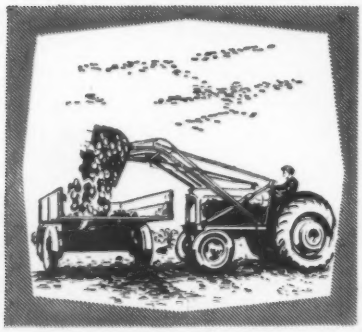

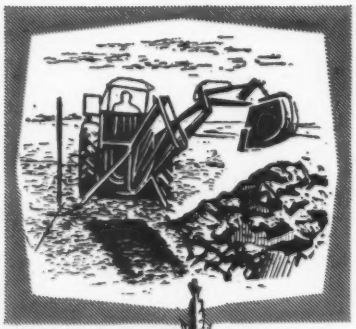

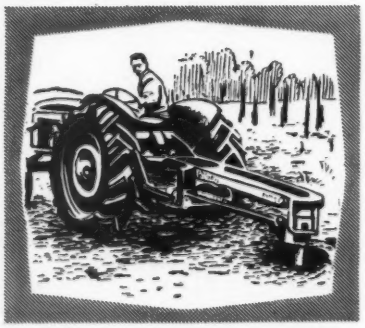

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The Himalayan Beas Basin: A Hydrographical Study

By

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AUTHOR

Detailed studies of the hydrography of the various rivers and river basins in India have not been made. Even systematic records of river discharge for long periods are not available. There is no doubt that on the correct understanding of the flow-regime and river-behaviour depends the efficiency of irrigation and control and regulation of floods.

Here, an attempt is made to record and interpret the various aspects of the Hydrography of the Himalayan Beas Basin (Fig. 1). It is necessary that a proper account of drainage basin, its topography, geology, climatic influences, vegetal cover, the drainage channel, discharge data etc. must be made so as to reach an understanding of the hydrology of a river, the occurrence of precipitation and its disposal.

The Beas is an ancient river and reference to it is found in Rig Veda (2,500 B.C.). Its vedic name was Arji Kiya.[1] In 1500 B.C. it was known as Vipasa and the Greek historians mentioned it as Hyphasis (300 B.C. to 140 A.D.).[2] The present name, Beas, is derived from Vipasa. According to the local legend the sage Vyas did penance at the site of its source, Beas Rikhi (Rishi) and since then it is known as Beas. The name Beas remains although the western affluent near the source is much bigger.

Area, River Pattern, Topography Gradient, etc.

The entire drainage basin of the Beas (Fig. 2) covers an area of 5,600 square miles and of 5,384 square miles only in the Himalayan Basin. The greater part of it lies high up in the mountains and the valleys (see Plate 1). Of the five great rivers of the Punjab, only Ravi has a smaller drainage basin of 3,100 square miles, as is evident from the following table of the catchment areas :[3]

Name of the River	*Catchment area in sq.miles*
Sutlej	18,500
Jehlum	13,000
Chenab	10,500
Beas	5,600
Ravi	3,100

The Beas takes its rise in the Pir Panjal range at the Rohtang Pass, near the headwaters of the Ravi, at a height of abount 13,050 ft. (nearly 4,000 Metres). It is a small stream at the source and takes its first water from a small spring, Beas Rikhi, though some distance away large quantities of water are added by the melting snow and glaciers. The river already swollen by large tributary streams pierces the Dhauladhar range at Larji, 75 miles from its source. It records an average fall of 125′ a mile upto Larji, after that gradient becomes gentler and in the valleys below it is hardly more than 10′ a mile.

South of Larji the Beas crosses through a steep defile below Mandi intersecting the Dhauladhar range (see Plate 2). The tributaries of the Beas make intricate patterns like a 'bunch of ferns'. The main trunk has about 16 important tributary streams. The main stream is like a crescent, the dip of the crescent slicing off ⅓ of Mandi and Kangra proper. The western tip turns northwards towards the undulating country of south Kangra and flat uplands of Hoshiarpur. The river flows in four directions ; in the beginning it flows southwards, then it runs westwards in the middle course in the valley, from Naduan it turns north-westerly and a few miles above Naushera, it turns southwestwards. In Mandi and Kangra it is a river flowing up the map.

In the upper catchment area, the chief tributary streams on the right are Solang, Manalsu, Sujoin, Phojal, and Sarvari while on the left are Parbati, Malana, Hurla, Sainj and Tirthan. The Parbati is as large as Beas itself. The drainage of Beas extends upto Jalori ridge which constitutes the Southern boundary of the Inner Beas.

Almost the whole of the drainage of Mandi district of Himachal Pradesh falls into the Beas river. From Mandi the river turns northwards. Further, it receives the waters of Uhl, Luni and Rana on the north bank, Bal, Suketi and Barakar on the south bank.

The river enters Kangra proper at Sanghol. Here

[1] Burrard and Hayden, Geography and Geology of Himalaya Mountains and Tibet, Part III, 1934 Edition, p. 233.
[2] Cunningham, A. Sir, "Ancient Geography of India", 1924 Edition, p. 159
[3] Burrard and Hayden, Geography and Geology of the Himalaya Mountains and Tibet, Part III 1934 p. 178.

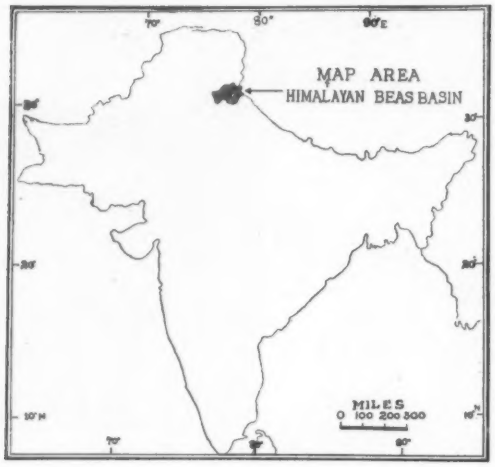

Fig. 1.

the main affluents are from the snowy Dhauladhar range. They are Binua, Awa, Niugal, Buner, Manuni Bated, Dehr, Jabbar and Chakki on north bank and Lunkar, Kunah and Man on the south bank. Each of these tributaries is swelled by accession of many petty rivulets. The south bank tributaries are few and unimportant. After flowing through the vale of Naduan and the longitudinal Jaswan Doon, the river reaches Mirthal (1000′ above Sea level) where the 'liberated river' sweeps around the base of low hills of the Siwalik and runs in an uninterrupted course. South of Pathankot the river makes a large loop, the Beas sweeping round and after long parting again approaches within 16 miles of Ravi. The river flows south in a straight course of approximately 88 miles before joining up with the Sutlej at Harike.

The Himalayan Basin of Beas is bounded by high mountain ranges on North-West, North, North-East and East. The Dhauladhar range in the North-west and North with an average height of 12,000 feet above sea level separates the waters of the Ravi from that of the Beas. The Pir Panjal range in the north-east with an average height of 16,000 feet above sea level forms the waterparting between the Chenab and the Beas and in the east the Great Himalayan Range with an average height of 18,000 ft. constitutes the watershed between the Spiti and the Beas. To the south and south-west the Siwaliks with an average height of 1,500 feet, act as the water divide between the Sutlej and the Beas. There are snowy ranges in the north and east which contribute meltwater to the main volume of flow in the Beas.

The river flows through Kulu valley (average height 4,000 ft.), Mandi (average height 2,500 ft.) and Kangra (average height 2,000 ft.) and finally at Harike the average level is about 650 feet. The fall from source to Larji, a distance of 75 miles is 125 feet in a mile, from Larji to Sanghol it is 1,080 feet, and from Sanghol to Mirthal, the fall is 1,920 feet. There is a total fall of 12,050 feet from Rohtang to Mirthal, that is from the source to the point where the river debouches onto the plain. Thus it will be seen that the gradient is too steep in the upper reaches. There is a fall of 6,000′ in nine miles from source to its junction with Solang, which is very spectacular. But in the middle and lower reaches the gradient is gradual. Between Mandi (2,473′) and Dehra Gopipur (1,421′) there is a fall of approximately 1,000′ in a straight distance of 45 miles and in river course of approximately 65 miles. Average bed slope for the whole drainage basin is 1 : 400, source to Larji is 1 : 42, in valleys is 1 : 528 and over plains is 1 : 5000.[1]

The river course is transverse to the general direction of the mountain region. Oldham[2] describes the hill features to be of denudation type. The features of elevation and drainage strongly impress the denudation type of hill contour on the Lower Himalayan region which are characterised by the close re-occurrence of irregular ridges and equally irregular river courses transverse to the general direction of the mountain region. Below Mandi the river enters the middle valley stage and tortuosity increases.

Beas to Harike[3]

Direct Distance	..	174,000′
Main stream distance	..	195,000′
Tortuosity	..	12%

Reduced distance in canal miles from Junction with Sutlej at Harike[4]

Site	*Direct*	*Mainstream*	*Tortuosity*
Harike	0	0	0%
Wazir Bhuller	35	38	8.5%
Naushera	76	82	7.8%
Pang	111	121	9 %
Usaffar (on Sutlej)	50,000′	70,000′	40 %
Upstream (on Beas)	50,000′	59,000′	18 %

Geology

In the upper reaches of the river the rocks are mostly hard crystalline and metamorphic. They consist of intrusive granite and gniess, schists and other metamorphic rocks. These rocks form the major portion of Kulu and Saraj. South of these, metamorphic sedimentary rocks extend from Chamba across Kangra to Simla Hills. They consist mainly of limestones, slates, quartzites and conglomerates. The Dhauladhars are also mostly composed of granite and other crystalline rocks which are a resistant strata. Lower down, the rocks are more recent and less resistant to erosion. Here, "The sub-Himalayan zone is composed of sediments for the most part of tertiary age and include some sub-recent deposits".[5] These rocks are found from Siwaliks in Hoshiarpur to the base of the Dhauladhar range. The rocks conconsist of losely aggregated conglomerates, sandstones red and purple clays and shales. The deposits are of immense thickness and are easily eroded.

Climatic Influences

Meteorological data about the Beas Basin is avail-

1 United Nations, Bangkok 1952. Proceedings of the Regional Technical Conference on Flood Control in Asia and Far East, p. 112.
2 Oldham, Mem. G.S.I. vol III, Part II, p. 6.
3 S. E. Bhakra, Dec. 1930 Report; Punjab P.W.D. Irrigation Branch p. 120.
4 S. F. Bhakra, Dec. 1930 Report, Punjab P.W.D. Irrigation Branch p. 139.
5 Burrard and Hayden 1934, Geography and Geology of the Himalaya Mountains and Tibet Part IV.

Fig. 2 Tinted areas show snow-fields and glaciers.

able only for a few places. Catchment areas are usually in difficult terrain and sparsely populated areas and generally no rainfall recording stations are found there. Therefore the average rainfall is often assumed chiefly with reference to that recorded at stations outside the main chatchment area and the data about rainfall or runoff is based on rather limited knowledge. The few rainfall observation stations in the Beas Basin are located in tehsils and district headquarters.

Taking an average of 8 stations per thousand square miles, there should be at least nearly 45 recording stations in the Beas Basin, while we have only about a dozen stations at present.[1] Statistics of rainfall etc., should also ve available for the area adjoining the catchment area.

In the hill country south of Pir Panjal and the Dhauladhar range the average annual precipitation varies from 50″ and 120″. North of Dhauladhar, towards Kulu and Banjar, the precipitation averages 40″-60″.

Rainfall is heavy during July, August and September and causes floods and erosion. A second maxima is experienced in December and January when westerly disturbances give a rainfall on an average of 5″-6″.

Average precipitation over the hill catchment area is 43.1″ in summer and 13.2″ in winter.[2]

1 Buckley gives the following number for the catchment area:

Area in sq. miles	*No. of stations*
0-50	1
50-100	2
100-200	3
200-350	4
350-500	5
500-700	6

2 Flood Control Series No. 1 U.N.O. Bangkok 1950, p. 38.

Plate 1—Kangra Landscape

Average rainfall of past years (in inches)

	Jan.	*Feb.*	*Mar.*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
Kulu	4.22	4.36	4.31	3.04	2.14	2.31	5.70	6.19	3.22	1.02	0.68	1.72
Palampur	4.63	4.61	3.50	2.06	2.29	7.76	31.22	32.51	10.10	1.15	0.44	1.92
D. Sala (Upper)	4.05	6.40	4.30	2.58	1.52	7.69	30.48	34.30	11.66	1.72	0.37	2.17
Kangra	2.89	2.88	2.35	1.14	1.49	5.58	21.76	26.06	7.05	0.58	0.32	1.37
Hamirpur	2.66	2.39	1.75	0.95	1.14	3.79	15.54	15.86	5.60	0.48	0.26	1.16
Nurpur	3.74	3.15	2.42	1.14	1.20	4.00	17.10	19.40	5.92	0.69	0.35	1.61

The Dhauladhars lie across the direction of the S. W. Monsoons and heavy precipitation occurs. Rainfall in the catchment area generally decreases from west to east and from north to south as is evident from the figures above. Relief control of rainfall is evident. Variety of landforms give a variety of local variations. The southern slopes of the Dhauladhar are amongst the rainiest parts of India. Temperature varies with altitude. Snow lies above 12,000 feet on the Dhauladhar, Pir Panjal and the Great Himalayan range, for most part of the year. Most of the snowfall which is fairly heavy results from winter depressions. Mountain and valley glaciers abound and add large quantities of meltwater to the Northern tributaries of the Beas. Snow survey in any part of India much less in this area has not been made but there is no doubt that these 'rivers of ice' are sending large supplies of water to the Beas. Snowfall takes place in winter in places attaining to an altitude of 6,000 feet but in exceptional years the snowfall may occur even in places as low as 3-4 thousand feet. There are several glaciers at the sources of the Beas and its northern tributaries in the snow mountains of Sirtkand Dhar, and numerous valley glaciers exist in the Pir Panjal and the Dhauladhars. Melting of snow begins towards the end of March and forms the main source of water till June. When the heavy downpour of summer monsoon sets in, variations in river flow and general rise of water raise problems of flood and erosion and point to the necessity of more stations for scientific rainfall and snow record, so that advance information about floods could be given as is done in the Tennessee Valley in U.S..[1] Detailed surveys of snow and glaciers should also be made. Relation between the meteorological and the hydrological phenomenon is well marked in the case of rivers like the Beas.

Vegetal Cover

Forests cover the slopes and inner valleys of the mountains and hills. Infact forests constitute one of the chief wealths of this mountainous and hilly tract. In the valleys and adjoining hills, vegetation rarely forms a continuous block being separated by fields and habitations. The pressure of population on land is great and frequently the forests are heavily grazed and large areas are heavily eroded. Above the Alpine pastures at higher altitudes, naked rocks bare of vegetation are common sight. Oak and fir forests exist above 5,000 feet and below are the Chir pine and scrub forests. The reserved forests are alone left in

1 Lilienthal, E. David, "TVA', Penguin, 1945, p. 24.

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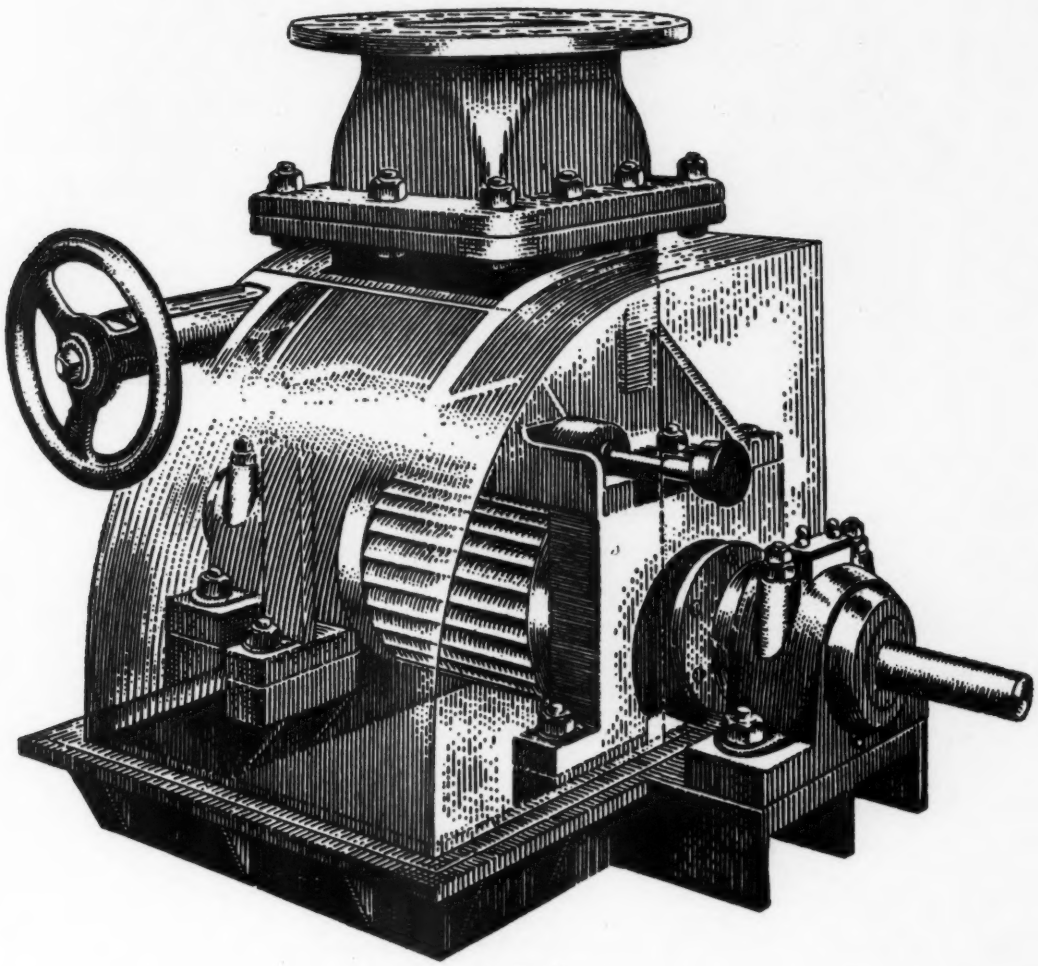

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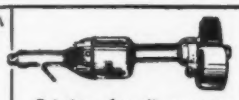

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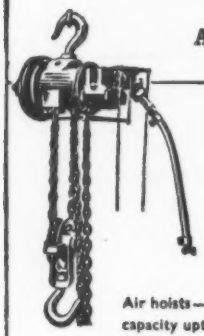

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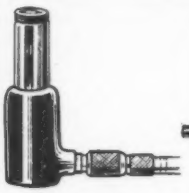

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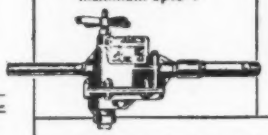
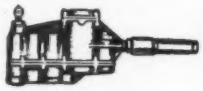


Close Corner Drills. Different capacity – upto 3"



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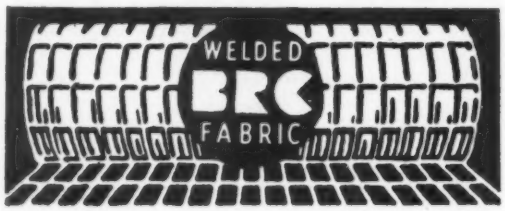

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Plate 2-Beas Valley

tact. Grazing and other rights in forests are more than liberal. The herds of the professional grazier and herdsman are far more than the forests can support. "The result of grazing, lopping and other forest usages, is the disappearance of the forests, the devastation of pastures and wholesale erosion of soil"[1]

In places, oak has been replaced by rhododendron, which alone is left uneaten by the ravenous goat. "The forests of the lower hills are mere denuded waste with a few Garna (Carissa spinarum) Basuti (Adhatoda vascica) and Sanotta (Dodonea viscosa) bushes".[2] The practice of annual burning of hayfields leads to erosion and sometimes spreads fires to nearby forests and causes great damage to vegetation. The extension of terraced cultivation is also reducing the area under forests. Grazing incidence is 1.26 per acre and it is estimated by Glover that there is an animal popula of over 10 lacs against human population of 7½ lacs. Even a casual observer cannot fail to notice the havoc caused by heavy rainfall on bare surfaces, when sometimes 8″-10″ rain falls in one day. The need for the conservation of natural vegetation and its scientific maintenance and exploitation is very great in this area, which forms the catchment area of the Beas. The increasing intensity of the floods is sufficient warning. Natural vegetation cover not only provides for regular supplies of water but also ensures against rapid runoff, soil erosion and floods. In Kulu the forests are in much better condition. More important than climate, soil and slope, in the control of runoff is the condition of plant cover. The ideal catchment area has been defined as one which is "completely clothed in either forests or grassland, where the natural vegetation has been preserved undisturbed and has been allowed to build up a deep soil profile".[3]

Recent investigations emphasize the careful retention of plant cover on all agricultural and waste land which is not actually ploughed. In an over enthusiasm for 'Grow More Food', forests and pastures and wilderness should not be considered waste.[4]

The measure of a river's efficiency is its average flow and this happens only where the vegetal cover is fairly preserved. Illustration of the effect of vegetation on runoff and erosion is given by the following figures :

Nature of cover	*Loss of Water*	*Loss of Soil*
Forest	1	1
Grass	27	32
Bare land	125	800

The Beas basin needs the combined efforts of the forester and the people to conserve and restore natural and essential vegetational cover. "Forest destruction is resulting in increased burden of detritus from soft tertiary rocks of the lower hills upon the streams be-

---

[1] Glover H. Sir, 'Erosion in the Punjab its, causes and cure', 1944, C.M. and G. Lahore, p. 88.

[2] Ibid, p. 88.

[3] Gorrie, R.M., 1937, "The Economic Importance of Changes in Plant Cover', Journ. Ind. Bot. Soc., vol XVI, No. 4, p. 210.

"The land of the catchment area may be forest or hill pasture or a wilderness of rock and snow with no intrinisc value of its own, but when assessed in terms of the water it produces, and the large investments in property, canal, development, reservoirs, machinery and human welfare all dependent on water supply it produces, the value of such catchment area must be very large indeed..... In terms of investment, therefore the land which produces this water carries a value of Rs. 700/- per acre although from the hill zamindar's point of view it is only fit for grazing a few herd of sheep and goats and brings in practically no revenue to the government other than its value as catchment area."

[4] Gorrie, R. M., 1937. 'Causes of Floods in Punjab', Ind. Forester, Feb.

fore they enter the area of deposition.[1] A great quantity of detritus is left behind obliterating the condition of slope required to produce Tarai zone, resulting in accummulation of sand for which there is no water-power to carry it further.

Discharge and Flow Regime

Beas occupies second place amongst the Punjab rivers for ratio of discharge to area, Chenab being first.

The average annual discharge does not appear to have direct relation to the actual size of the catchment basin. Only in the case of Ravi the smallest basin has also the smallest discharge. Discharge differences of annual flow have far less significance than the seasonal differences that reflect the incidence and variation of precipitation over the mountain catchment areas.

[2]

Name of river	*Order of magnitude*	*Himalayan area included in the catchment Basin*	*Total discharge of water in one year (estimated)*	*Ratio of discharge to area taking that of Ravi to be unity*
Indus	First	103,800	9	0.3
Sutlej	Second	18,500	3.5	0.6
Jhelum	Third	13,000	5.5	1.3
Chenab	Fourth	10,500	5.5	1.6
Beas	Fifth	5,600	2.5	1.3
Ravi	Sixth	3,100	1	1.0

Ratio of discharge to Ravi

Discharge and variation of discharge of Beas at Mandi Plain[3]

Months	*Mean monthly discharge in cusecs.*			*% above and below 20 years average* (1923-42)	
	Max.	*Min*	*Average*	*Above*	*Below*
January	8,431	3,266	4,641	Plus 82	Minus 30
February	12,257	3,097	5,694	,, 115	,, 46
March	10,364	3,333	6,350	,, 63	,, 48
April	12,373	3,499	7,528	,, 64	,, 54
May	16,706	4,027	9,663	,, 73	,, 58
June	27,310	9,209	15,055	,, 81	,, 39
July	69,010	13,314	40,516	,, 70	,, 67
August	129,574	17,724	61,302	,, 111	,, 71
September	65,456	16,169	30,081	,, 118	,, 46
October	31,029	6,812	10,337	,, 200	,, 34
November	7,622	4,311	5,548	,, 37	,, 22
December	6,933	3,851	4,839	,, 47	,, 20

Hydrological data of some Himalayan Catchments[4]

Name of river	Catchment area at debouchment in plains (sq.m.)	Area under glaciers (sq. miles)	Percentage (3) to (2)	*Maximum recorded flood (Approx.) cusecs*	Mean annual rainfall (inches)	*Run-off in acre feet*	Percentage run-off of rainfall	Minimum recorded discharge (cusecs)	*Minimum monthly discharge (cusecs)*
1	2	3	4	5	6	7	8	9	10
Indus	118,400	14,415	12.2	10,00,000	17.74	87,355,000	77.98	18,870	26,584
Brahmaputra	99,200	9,400	9.5	...	...	1500,00,000	...	...	...
Jhelum	12,445	142	1.1	8,00,000	42.33	23,860,000	84.93	4,500	7,246
Chenab	11,399	1,475	13.0	7,50,000	47.24	23,277,000	81.06	3,884	6,830
Ravi	3,562	100	2.8	2,00,000	93.00	6,541,000	40.89	1,332	2,086
Beas	5,398	277	5.1	5,00,000	56.50	12,546,000	77.34	2,600	4,641
Sutlej	23,400	2,468	10.5	4,00,000	19.71	13,938,000	56.67	2,818	4,325
Jumna	4,470	131	2.9	4,00,000	73.00	8,296,000	47.90	2,459	4,242
Sarda	5,788	666	11.5	...	70.00	17,630,000	82.90	4,200	5,380
Kosi	23,808	2,228	9.4	7,00,000	60.00	40,600,000	60,00	7,000	10,000
Teesta	3,200	300	10.7	...	80.08	11,520,000	84.40	2,500	4,000

[1] Medicot, H. B., 1883-84, 'Sketch of the Geology of the Punjab', p. 10.
[2] Burrard and Hayden, 1934, 'Geography and Geology of the Himalaya Mountains and Tibet,' Part III, p. 175.
[3] Kanwar Sain, 'The Role of Glaciers and Snow on the Hydrology of the Punjab', Cent Board of Irrig. Govt. of India, pub.No. 36.
[4] Quoted by R. M. Gorrie in 'Soil and Water Conservation in the Punjab,' 1946, p. 190.

Rain gauges are kept at Hamirpur, Palampur, Nurpur, Dera, Gopipur, Dharamsala, Kangra, Kulu, Jogindernagar, Sarka Ghat, Chichiot and Mandi. There are in all five gauge sites and three discharge sites on the Beas.

Gauges are at Larji, Mandi Hill, Pang, Nandera and Beas railway bridge and discharge sites are at Dera, Gopipur, Sujanput, Tira and Mandi plain. At Larji the lowest discharge during the winter of 1942 was 1782 cusecs while the maximum winter discharge was 5697 cusecs and the maximum surface velocity was 4.07 feet per second. In summer the maximum discharge was 49,059 cusecs and surface velocity was 14.29 feet per second. The minimum discharge was 4228 cusecs. The movement of the bed here is within narrow limits. The entire reach of the river between Mandi and Larji is punctuated with frequent rapids up which no navigation craft can be towed. Observations are being made to ascertain available supplies in the River Beas in connection with the proposal for the dam on the river.

Mandi Hill site gauge is on the left bank. During 1944, the highest gauge mark was 28.4 feet in August and lowest 3.39 feet in February.

Sujanpur Tira Discharge Site is situated 1.5 miles downstream of the Sujanpur Tira ferry. Maximum discharge in 1944 at this site was 1,61,684 cusecs and minimum was 2,475 cusecs. Another proposed site is Balehu 7 miles downstream of Sujanpur Tira.

At Dera Gopipur the zero level of the gauge is 1323.52′ R.L. The highest recorded gauge at this site in 1944 was 32.70 feet and the lowest was 0.40 feet.

At Pang the site lies on the left bank of the river Beas opposite village Pang. The zero level of gauge is 1069.21 feet R.L. Highest recorded gauge level was 37.5′ in Auguest and lowest was 4.1′ in February.

At Mandi Plain the site is situated about 8 miles above the junction of the Beas with the Sutlej where the gauge is kept since 1919 and dlischarges measured since 1921. Here the discharge represents the collected supplies of the entire basin. The maximum discharge during 1944 was in August when it amounted to 2,22,000 cusecs and the minimum was 4,020 cusecs in February, which represents a variation of more than 50 times.

Some observations on storage sites are made at Haripur on Banganga, Nurpur on Jabbar Khad, Dhawala on Nakchar, Basa on Gaj, Bagrur on Dehr, Khannin on Chakki and Chakki Road Bridge.

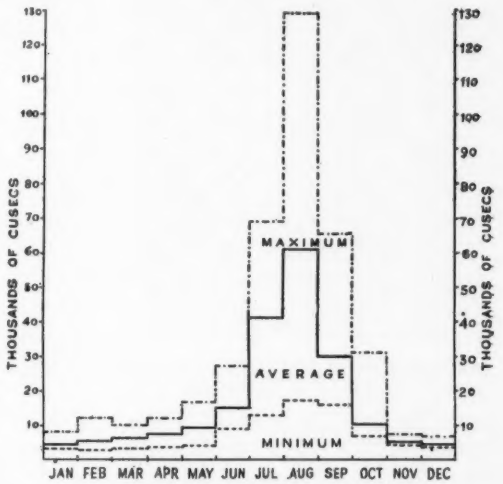
Flood warnings are issued from Dehra Gopipur, to the heads of the civil authorities and others concerned.

It is also being explored whether it should be possible to divert supplies of water from Beas to Sutlej. The probable link is via Kunah, Lunkar Khud to Sutlej. This will augment the supplies of water for Bhakra dam.

Sir Alexander Cunningham put the minimum discharge of the Beas at 'not less than 3,000 cubic feet per second'.[1]

However, there are great variations in volume of flow. The high flood is about "2,00,000 cubic feet per second. The highest recorded flood is 3,84,000 cubic feet per second (1942). The dominant discharge of the river is about 70,000 cubic feet per second".[2]

Silting and scouring depend, to a considerable extent, upon the nature of the Monsoon itself. Large quantities of sand, silt and pebbles are carried down stream especially during the rainy season when the raging streams present a muddy appearance. In a sample survey[3] the mean diameter of the river bed material and shoals was given as 0.16-0.18 mm. and 0.13-0.18 mm. respectively. The material of the river bank is mainly composed of clay. During rainy season even boulders of considerable size are carried downstreams.



BEAS - DISCHARGE AT MANDIPLAIN

Fig. 3

In Beas the regime changes in the river level vary with the seasonal variations of flow (fig 3). January has the lowest average flow of 4,641 cusecs. Rain at this time is very little and the melt water from snow and glaciers is meagre. The flow is greater in drier months of March, April, May and June because of large quantities of melt water. The level of the Beas rises and as early as June the ferry bridge at Dehra Gopipur has to be disbanded. In June the average flow is 15,055 cusecs. The highest average flow, however, is in the rainiest month August, when as much as 25″ of rainfall takes place in catchment areas. The region south of the Pir Panjal and Dhauladhar has the heaviest summer rainfall; therefore, the river with a large catchment area in this tract will have greater summer discharge. The greater unit area discharge of the Beas as compared to Ravi can be thus explained.

Large parts of Ravi catchment lie north of Dhauladhar but a large part of the Beas valley lies south

[1] Burrard and Hayden, 1934, 'Geography and Geology of the Himalaya Mountains and Tibet', Part III, p. 233.

[2] United Nations, Bangkok, 1952, 'Proceedings of the Regional Technical Conference on Flood Control in Asia and Fat East' Series No. 3, p. 111.

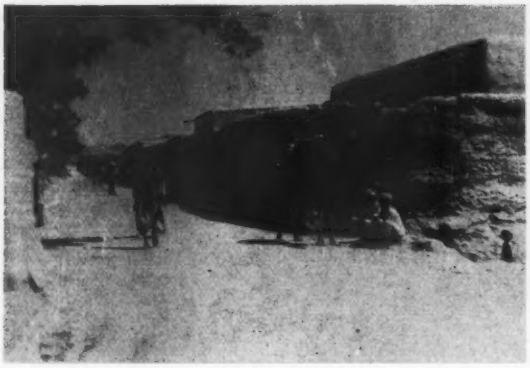
[3] Ibid, p. 110

Continued on page 14)

Development of Water Resou

2—Primitive method of plowing with camel-drawn plough in a semi-arid area near Mastung, in Baluchistan.

3—A view of one of the wells in an arid area of Baluchistan where subsistence farming is the rule for 90 per cent of the population.

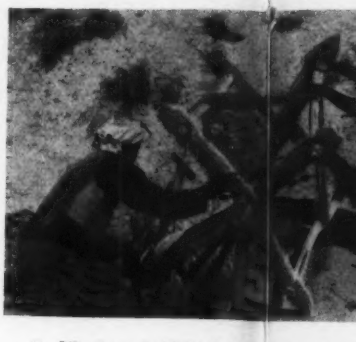


1—A Balouch village scene near Mastung in Baluchistan.

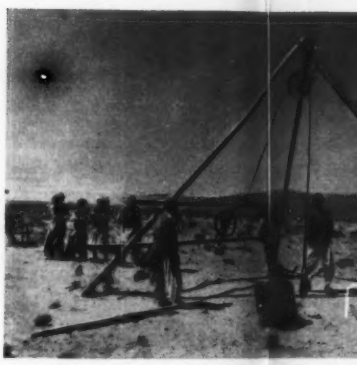
An adequate supply of water is the first essential for economic development in Baluchistan, where subsistence farming is the rule for some 90 per cent of the population. It is thought that as long ago as 2000 B.C. a large population of agriculturists lived prosperously on the great expanses of land, but today a relatively sparse population must contend with wretched conditions in their effort to wrest a living from the parched land, now dotted with mounds indicating ancient settlements and cities lost under the sand.

Deeply concerned over the plight of the inhabitants of the area, the Pakistan Government sought advice on the general development of Baluchistan, inspired by the thought that these desolate areas could be made to flourish if water is found, as was done in formerly arid regions of the Sind and Punjab Provinces. Specialists of the Food and Agriculture Organization of the United Nations (FAO) and a hydrologist from from the U.N. Technical Assistance Administration (UNTAA) were asked a conduct surveys and found that water was available deep underground. The UNTAA hydrologist estimates that conditions com-

4—A camel-driven Persian well in operation.



5—Workers in Baluchistan use an anc drawing wate from a w



6—A simple drilling apparatus designe FAO experts, using motorcycle wheels

7—Prospecting for water in an arid area Baluchistan.

esources in Baluchistan

se an ancient method for from a well.

s designed by one of the le wheels and 4" pipes.

arid area near Mastung, stan.

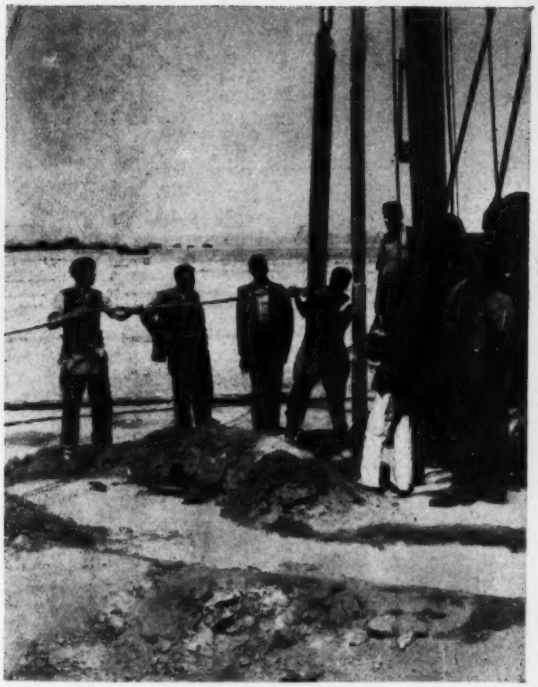
10—A FAO-trained tractor driver at work plowing an irrigated valley near Quetta.

parable to those in California could be produced, if as little as 25 per cent of the rainfall on the mountains could be utilized, and has made recommendations for reducing the present high loss by evaporation from water channels. In 1954, working with a UNESCO geophysical team, the flow from existing wells in the Wad Valley, fifty miles south of Quetta, was increased to 40,000 gallons per day and there is hope that this flow can be doubled in due course.

The principal aims of the Water Investigation and Development Unit, formed by the Baluchistan Province and FAO experts, are to improve the use of existing water supplies, discover and develop additional supplies and to train personnel in these techniques. The advance party of a seven-man FAO team began work in three areas early in 1955, initiating a five-year programme under which development of the water resources of the region is progressing rapidly.

The illustrations here depict the work of the FAO and UNTAA in the region.

11—An example of controlled irrigation, near Quetta, Baluchistan.



8—Mechanical well drilling in a village compound near Quetta in Baluchistan.

9—An expert in tube-well drilling tests the yield from a new well in Quetta.

Photographs by United Nations.

(*Continued from page* 11)

of this range. Infact the summer flow of the Bease is comparable with that of the much larger Sutlej, whose narrow basin between the Great Himalayan Range and the plains presents a relatively smaller gathering ground in a region of heavy rainfall.

In October the river begins to fall rather rapidly. From an average flow of 30,081 cusecs in September, it reduce to 10,337 cusecs in October. Until February the discharges are small. February has an average discharge of 5,694 cusecs. During autumn the flow is largely the result of preceding monsoon rainfall, mostly in the form of seepage. In winter the supplies are small though the rainfall increases westwards in the Outer Himalayas giving more supply to Beas than to Sutlej. Floods occur in Beas usually in late August and September. In September 1950, the Beas flooded 300 villages around Kapurthala and even the road connecting Kapurthala with the Grand Trunk Road was under water and vehicular traffic was stopped.[1] This was due to excessive rainfall of high intensity in September.

There are definite differences between the various parts of the river ; the condition in the upper reaches are different from there in middle and lower reaches.

River Channel Developments

In B.C. 327 the Beas flowed as an independent river and its channel ran parallel to that of the Sutlej. Signs of the abandoned old river bed are still found and it joined the Indus probably lower down the point where Marud Vradha (Lower united course of Chenab and Jhelum) now join it. It appears that the upheaval of the land of Rajputana sea offered an obstruction to its bed and caused it to deflect its course towards west till it joined Marud Vradha. At one time the Vipasa (modern Beas) and Satadru (modern Sutlej) flowed into the Rajputana see (*Rig Veda*, VIII, 23, 3). Evidence from old maps[2] shows that Sutlej was also affected and its upper course over the plains deflected westwards till it captured the Beas and now the Beas and the Sutlej unite at Harike above Ferozepur. In the upper catchment areas there appears to be likelihood of the water-parting between the Beas and Sutlej to recede further to the north, i.e., the southern drainage basin will be more and more captured by the tributaries of Sutlej. Sutlej flows in a deeper bed than Beas. "At corresponding points in the mountain the beds of Giri and Beas are relatively higher by 600 or 700 feet than that of the Sutlej, so that the latter is running along a deeper trough than the rivers on either side of it".[3]

Increased depth of trough would mean steeper slopes and these will give greater erosive power to the tributary stream[2]. The basin of Sutlej in the outer-Himalayas would therefore widen so that the Western Water-Parting of the Sutlej would retire towards the Beas.

A new change in the course of Beas in Bist Doab was marked in 1870 when it started deflecting towards east. Left bank of the river suffered much erosion and the main channel has shifted towards the left since 1938. On the east bank of the river there is the course of Western Bein about ½ mile away. The bed of the western Bein is 10 feet lower than that of the Beas and therefore it is but natural that the river will tend to merge eastwards with Western Bein. If that takes place, it would naturally mean, in addition to devastation of land, the building of new rail and road bridges. The Punjab Irrigation Department is making efforts to stop this easterly drift of the course of the river. The eastern bunds provided between the river and the western Bein did help in stopping the spill over but could not stop the change in the course of the river. So at a conference of Railway and Irrigation Engineers it was decided to take 'firm steps' to stop the easterly deflect. Stone aprons of 5% soil cement were constructed reaching higher than the 1947 high flood level. This was helpful. The easterly deflection has been stopped for the time being. "Rather the main current of the river was repulsed away from the apron"[4]. However, it cannot be said that the final stability has been reached. "33½ miles of flood protection works have been made at an approximate cost of Rs. 6,16,23,000"[5]. This has averted the danger of damage to the villages of Golwal, Prempur, Saidowal and Chhawrain. A recent report says that 'following heavy rains the Beas is rapidly changing its course north west of Dasuya'[6].

Besides the training works mentioned above the river is being closely studied for over ten years and model studies are being carried on at the Hydraulic Research Station, Malakpur, Punjab. Models of rivers are very useful and have been used with considerable success in India for over 15 years in studying most of the problems of river courses, floods and irrigation.

Below are given heights of selected places indicating curve of gradation of Beas River.

Place	*Height in feet above sea level*	*Reduced height in ft. above Harike*
Rohtang[7]	13050	12700
Manali	6000	5350
Kulu	3994	3344
Mandi Hill	2473	1823
Sujanpur Tira[8]	1637.16	987.16
Blehu	1561	911
Dera Gopipur	1323.52	673.52
Pang	1069.21	419.21
Mandi Plain	684.35	34.35
Harike[9]	650	

The graph (Fig. 4) shows that upto Mandi, the river pursues a Torrent Track and from Mandi to Pang it follows a middle valley course which is evident from

[1] Handa, C. L., and Sehgal, S. R., 'A review of the recent floods (1950) in Punjab (1), with suggestion for short term and long term measures'. Flood Control Series No. 3, U.N. Bangkok, 1952, p. 216.

[2] Cunningham, Alexander Sir, 'Ancient Geography of India' 1924 Edition; Map V facing page 120.

[3] Burrard and Hayden, 1934, 'Geography and Geology of Himalaya Mountains and Tibet', Part III, p. 227.

[4] Sondhi, D.P., 'Flood control at Beas training works in Hoshiarpur district, Punjab, India,'—Proceedings of the Regional Technical Conference on Flood control—Flood Control Series No. 3, United Nations Bangkok, 1952, p. 221.

[5] Ibid, p. 112.

[6] The Statesman, Delhi, dated, 26-8-55.

[7] Actual heights above sea level.

[8] Interpolated height.

Rest of the heights are zero R.L.

wide and braided channel and below Pang the river flows over the plain course whence the fall is slight.

Suggestions for Development and Control

A good deal of information on the conditions in the catchment basin is not available. Much that is known is divided amongst the forest, agricultural, meteorological and geological departments. Unfortunately no single authority can supply the entire information for the whole river basin as regards rainfall, temperatures, vegetal cover,slopes, landuse, discharge and channel developments. Fortunately the drainage basin of the Beas falls entirely within Punjab and Himachal Pradesh and complete investigations can be done with the joint effortts of the two governments. A river is an organic whole and the drainage basin of the river is the natural topographic unit. The problem of landuse, irrigation, floods vegetation and forests, hydro-electric power and water supply are interconnected. Therefore a unified authority must be set up to study these related problems. What such co-ordination can mean is evidenced from the results achieved by the Tennessee Valley Authority in U.S.A., and by the Damodar Valley Corporation in India. The problems of forestry, landuse and flood prevention etc. must be controlled by a joint board from Punjab and Himachal Pradesh. Detailed surveys of the catchment areas are necessary. The field party should include a hydraulics engineer, a geologist, a forest officer, an agricultural officer, a soil conservation officer, a meteorologist, a geographer, an economist and an administrator. Air surveys can also help in determining the conditions in the basin of the river. The geographer with his knowledge of regional concepts and cartographic skill can greatly assist in the work of river basin management.[1]

It would not be saying too much that such knowledge as collected by the centralised unit may mean gain of large sums of money by helping to prevent damage by floods and erosion and by suggesting proper utilization of the water by way of irrigation and waterpower. In the light of the facts stated earlier it is essential that a more rational and scientific policy should be vigorously pursued if scourge of floods and erosion is to be stopped and a healthy catchment area has to be maintained in the Himalayan Beas Basin. Surveys of snow and glacie s and a large number of rainfall recording stations are required.

Regime changes in level are important in the long term effects on the area comprising the basin. The pe iod of observation is small from which to derive conclusions and especially when there are so many conflicting and variable factors at work. Therefore whatever conclusions have been advaced are tentative and may need modifications. There is scarcity of proper sites for gauge level studies and even the records of the gauges depend "solely upon the sense of duty of low paid staff"[2] and re seldom reliable.

The work of observations should b so organised that the observations are always ten years ahead of projects and plans. In U.S.S.R. according to Mr. Shrov,[3] great attention is being paid to river regularegulation and study of life history of the rivers which enabled them to foretell future events of the river.

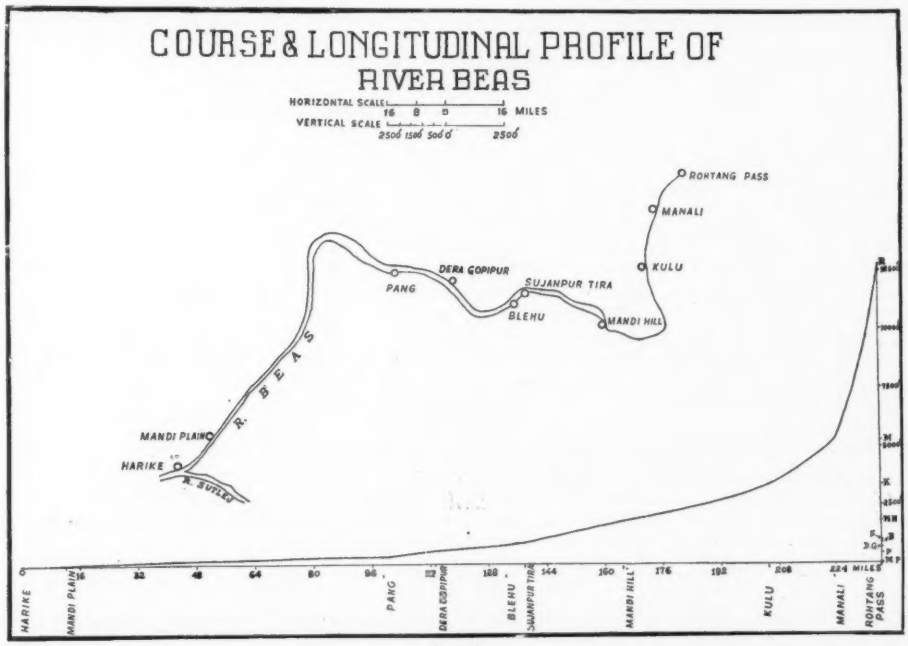


Fig 4

[1] 'Harlan, H. Barrows, Charles C. Collby, G. Donald Hudson, Edward Ackerman and Gilbert White have already helped in this direction'. David Brown and Vivtor Roterus—'River Basin Planning—Geographical Opportunities', Abstract Annals, A.A.G., vol. XLV, No. 2, June 1955, pp. 170-171.

[2] Foy, T.A.W., 1941, 'Regime level changes on the Indus System', Part 1, pb. Irrig. Branch, Paper No. 16, class B.

[3] Shrov, 'Flood Control Series III, U.N., Bangkok, 1952, p. 18.

There are several streams which have plentiful supply of water during rains but their supply decreases in winter and early summer. The water of the Beas is little used for irrigation in the Himalayan Drainage Basin but the water of the tributary streams can be stored by constructing small dams at suitable sites. Several such sites exist in Buner, Dehr, etc. Four dam sites on even Beas can be possible at greater expenditure, i.e., one near Larji, second at Balehu, third near Dehra Gopipur and fourth at Pang. A tunnel could be constructed of an approximate length of four miles at about 10,000 feet near Rohtang pass to divert the water of the Chandra river to Beas, and also at Marlu pass in the Chamba district of Himachal Pradesh, a 5-mile tunnel at 7,700 feet would transfer the waters into the Ravi.

It is also desirable to dredge the river channel of Beas corresponding to the Western Bein to avoid the possibility of eastern deflection.

The conditions of a river are properly revealed by Hydrographical studies. Just as weather forecasting involves study of weather types so also river regime types need careful study to know river behaviour.

A river basin and its water resources constitute an integral whole and should be managed for the benefit of maximum number of people regardless of the territorial boundaries. It is in the catchment area that development and solution of problem lies. These comparatively remote areas have received less attention and the author feels that greater study of various problems of Beas Basin is necessary and elsewhere in India similar studies should also be made.[1]

(*By Courtesy of the* National Geographical Journal of India, *Vol.* 1 *Part* 1).

[1] Fieldwork for this article was carried out in the summers of 1949, 1950 and 1951. The author acknowledges with thanks various helpful suggestions made by Dr. R. L. Singh.

(*Continued from page* 26)

A Scheme of Zonal Authorities

zonal and long-term basis rather than for individual projects as at present. It would also make for real planning, after proper investigation of zonal development and of each project in the zone, and the present, almost indecent haste with which projects are prepared and submitted *en masse* by the individual States, anxious to stake as big a claim on the Central funds as possible would be a thing of the past.

Pending the setting up of the Zonal Development Authorities advocated above, the present isolated State Organizations will of course continue, with their limited co-operation with each other for the execution of projects, in which they have a common interest. Every encouragement should be held out by the Centre to such project Authorities or Development Boards as have already been created, for the purpose of executing projects affecting more than one State, to extend their co-operation to the *planning* of other projects situated in the same region and affecting the same States. As the idea of Zonal Development Authorities catches on, the CW & PC should progressively restrict its activity to that of a Brain Trust for the country, but whether it continues to function as it does at present or confines itself in future largely to affording technical advice and assistance as indicated earlier, we would like to emphasise that its scrutiny of Projects or its advice on Projects, should be appropriate to its level. We have noticed a tendency towards too detailed a scrutiny of projects, which may be justified because of inadequate investigation and preparation of the projects submitted by the States, but this unsatisfactory state of affairs will only be perpetuated, if the CW & PC assumes a responsibility which properly devolves on the States.

Since the submission of this note the draft of the River Board Bill, 1955 has come to our hand. The main object of this Bill is to secure the basinwise planning of rivers or river valleys which is the basic idea behind the zonal development suggested in this Interim Report. We, therefore, consider the proposed legislation as a step in the right direction, though in our opinion *the purely advisory functions of the River Boards may not be enough* to secure the achievement of the desired results.

(*Continued from page* 24)

Draft Standard Specification for Distribution Transformers

Locations for fittings on the transformers have also been recommended in the draft Standard. These recommendations could be made obligatory should there be sufficient desire on the part of users to see the relative position of fittings on the transformer standardized.

To ensure minimum levels of electrical efficiency, limits for iron and copper losses have been laid down. The figures for iron loss (fixed loss) relate to electrical steel sheets of grades available in the country but it is hoped to lower them at a later date when steel sheets of higher grades become available. It has also been recommended that the impedance should not be lower than 3.5 percent.

The draft Standard recogni es an ambient temperature having a peak value of 50°C and an average value of 45°C over the 24 hours period.

The Institution would be glad to receive constructive criticism and suggestions for improvement of the standard by 15 June 1956. Copies of the draft standard can be had from the office of the Institution at 19 University Road, Delhi 8.

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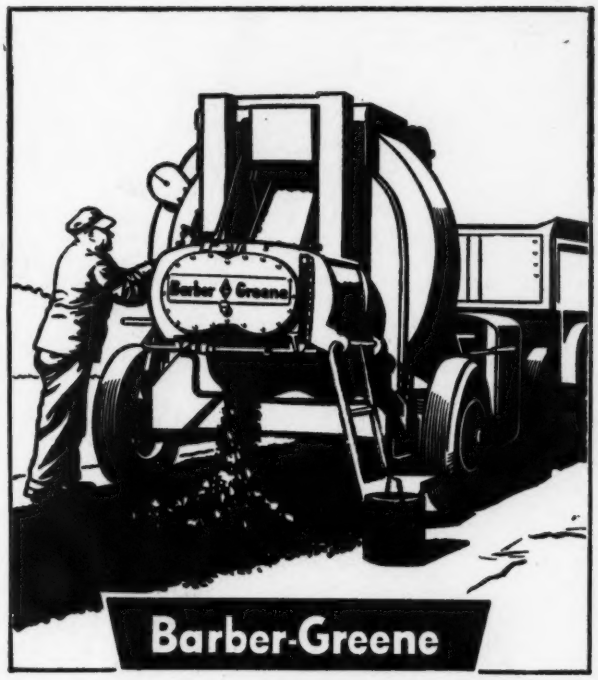

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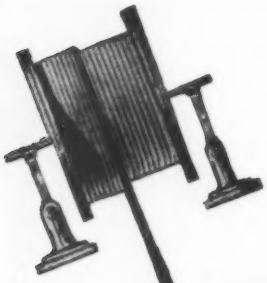

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Storfinnforsen and Laforsen Power Stations

The Storfinnforsen power station lies just north of Ramsele on the Fox river, a tributary of the Angerman river. It is owned by Krangede Aktiebelag, Stockholm.

Power Station

The station is equipped with three vertical Francis turbine built by *NOHAB*, which are directly coupled to three-phase alternators of *ASEA* make. The turbines operate under a net head of 48.5 m (160 ft.) at 150 r.p.m. developing 47,000 h.p. each. The rating of each alternator is 40,000 kVA at 18,000 V.

The machine hall is excavated from the solid rock, and the machine hall is roofed with reinforced concrete. The floor is about 25 m. (82 ft.) below ground level and 11 m. (36 ft.) above the highest lower water level at outlet from the discharge tunnel.

The machine hall is provided with windows intended to give the impression that they are above ground. Illumination is supplied by daylight lamps "outside" the windows.

As an additional safety measure, the roof over the spiral casings and the concrete walls for the turbine shafts have been designed to withstand the water pressure in the event of one of the spiral casings bursting and filling the surrounding space with water. Small tunnels connecting the various turbine shafts with the draught tube outlet provide drainage for the water in such an emergency. These tunnels have non-return gates which normally prevent the backwater from the draught tube outlets from entering the turbine shafts.

Penstocks

The three vertical penstocks, one for each unit, are excavated from the solid rock and lined with steel tubes embedded in concrete. They are about 54 m. (177 ft.) long, with an internal diameter of 5.7 m. (18.6 ft.). The horizontal distance between turbine and penstock centres is 25 m. (82 ft.).

Draught Tubes

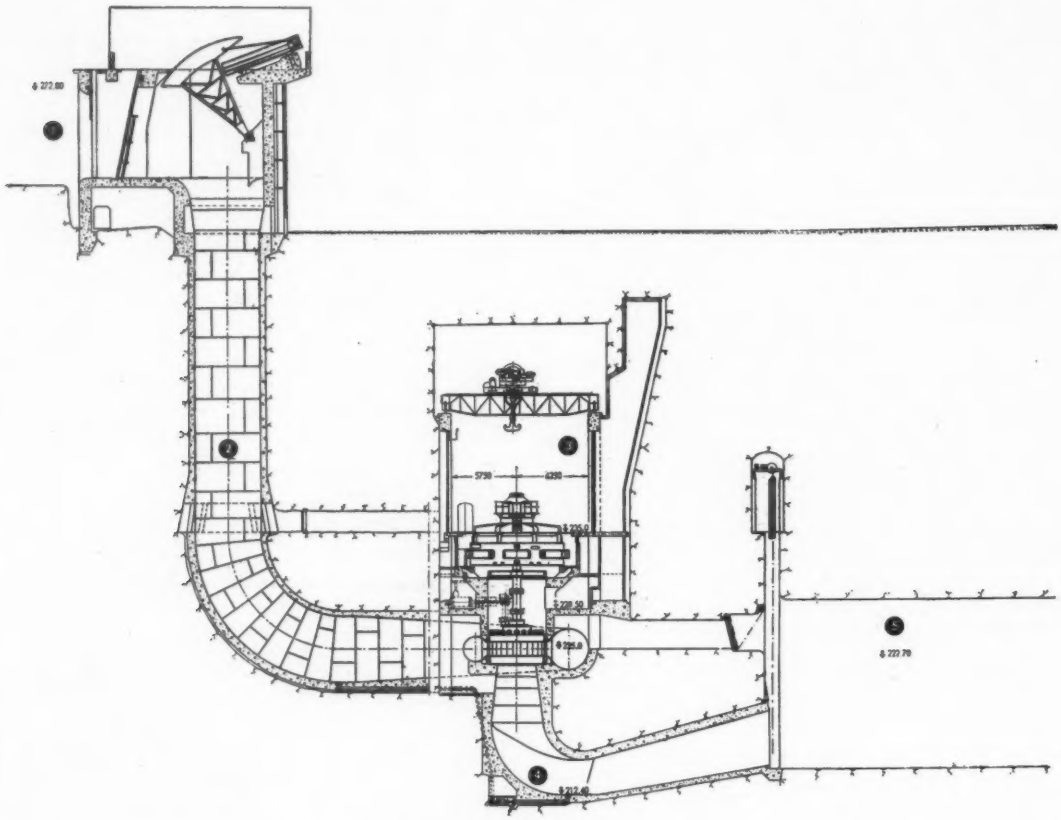
The upper conical sections of the draught tubes are lined with 25 mm. (1 in.) steel plate. The lower ends of the tubes are best at 90° and the lining thickness is reduced to 12 mm. (0.5 in.) there. The steel lining continues for a distance of 6.7 m. (22 ft.) horizontally from the turbine centre line. The three draught tubes open into a common discharge tunnel which is 375 m. (412 yd.) long and has a cross-sectional area of 116 sq.m. (1,245 sq.ft.).

Distributors

The distributors have 20 cast-steel wicket-gates and external control. The cover and lower rings are of cast iron. The surfaces of these parts adjacent to the ends of the gates are faced with replaceable steel plates and there are also replaceable steel rings round the periphery of the runner. The regulating ring is a steel casting and in order to reduce friction the ring is provided with radial roller bearings.

The wicket gates are connected to the regulating ring by means of breaking links which prevent damage to the gates in the event of any object jamming between two gates during regulation. Each link carries an electric contact which warms the station staff if the link breaks.

The Ekwall-Munding patented sealing devise is employed in the distributor. The turbine cover liner is in the form of a movable annular plate which lies



Sectional view of the plant
1. Intake 2. Penstock 3. Machine hall 4. Draught tube 5. Tail race

in a groove in the cover. When the gates are closed the water pressure forces the plate against the upper end surface of the gates, thus disposing of leakage water.

Further reduction in leakage is secured by recessing a rubber-strip into each gate along the surface where the tip of the adjacent gate makes contact when the gate is closed The link pins in the regulating ring are eccentric, permitting fine adjustment of the wicket gate settings and sealing.

An almost perfect sealing is ensued by using these two sealing arrangements in the distributor.

Runners

The runners are one-piece steel castings with 16 blades each. The throat diameter is 3.3 m. (10.8 ft.) and each runner weighs 27 tons. A layer of stainless steel is welded on to the areas of the runners where cavitation is liable to occur. The position and extent of these areas were determined in tests on model runners in the turbine laboratory.

To date, no cavitation damage whatsoever has been found, although at the time of the most recent inspection the first turbine installed had been in service for about 2 years, with occasional overloading of up to as much as 20%.

Spiral Casings

The inlet diameter of the spiral casings is 4.83 m. (15.4 ft.) and the thickness of the steel plate varies from 22 to 12 mm. (0.9 to 0.5 in.). The casings have welded transverse joints and are riveted to the stay rings. The stay rings are steel castings made in four sections and have 13 stays each.

Turbine Shaft Seals

The Hudn water-sealing gland consists of carbon seal rings which are held against the shafr with garter springs. The shaft is protected against weat by means of renewable liners made in two halves bolted together. A warning device indicates overheating in the sealing gland.

Turbine Cover Drainage

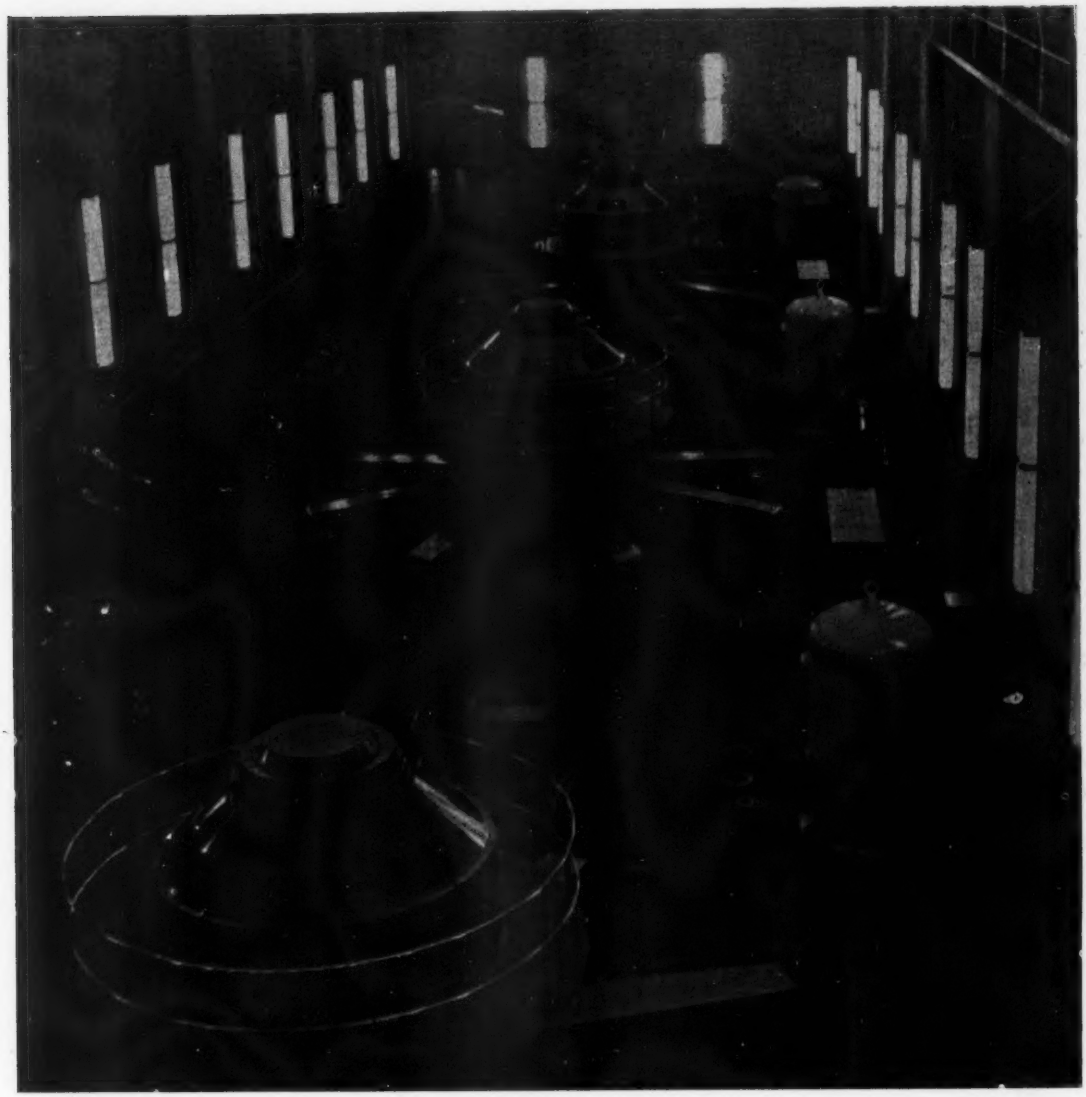
Leakage and condensation water is removed by an ejector. Each turbine has also an emergency pump driven by an electric motor, which is started by impulses from a float if the water on the cover should rise above the permissible level.

Governor Equipment

Each turbine unit has governor equipment comprising actuator, main servo motor and hydraulic unit.

Actuator

The actuator is of electro-hydraulic type, designed



Machine Hall of the Storfinnforsen Power Plant.

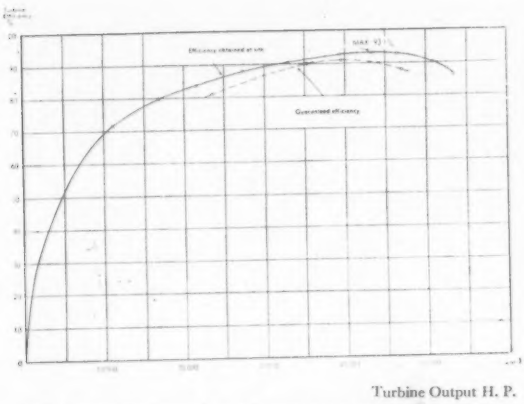
and manufactured by *NOHAB* in co-operation with *ASEA*. This is the type of actuator now being used in most large Swedish power stations.

The main factors to which the electro-hydraulic turbine governor responds are voltages, mainly A.C. These are compounded in an electronic governor, whose output impulse determine the flow of water admitted to the turbine.

In the actuator these impulses are transferred by means of an electro-magnetic system in the "electro-hydralic control unit" to the mechanical part, here they are amplified hydraulically. The voltage fed to the governor is derived from a tachometer generator.

The governor equipment includes gear for easy adjustme t of frequency, damping ratio, regulating capacity, etc., during operation. The governors can be connected for "joint operation", which makes the power station as easy to handle as if there were only one turbine unit. The load is always distributed among the turbine units so as to give maximum overall efficiency.

The governor can readily be altered to regulate different factors. Besides frequency also power output, water-level, mean out-flow, etc, can be regulated. The actuator also contains a solenoid-operated gate-lock which, in the event of a fault occurring, prevents the gates from opening beyond their position at the instant the fault occurs. In addition, there is a manual and motor-operated gate-limiter, which also serves as a manual control for the flow of water admitted. All the instruments are mounted on the front panel of the actuator cabinet and the electrical contactors and connections in a roomy, oil-free space in the rear of the frame.



Efficiency diagram for the turbines of the Storfinnforsen power plant. Net head 48.5 m. (160 ft.) Speed 150 r.p.m.

Main Servo Motors

In accordance with the customer's wishes, each turbine was provided with a regulating shaft which was coupled to a servo motor mounted on the floor above the spiral casing at level 228.5.

A system of links and levers transmits the control motion from the actuator to the main servo valve located on top of the main servo motor. The main servo motor actuates the regulating ring via the regulating shaft and a system of cranks and links.

Hydraulic Units

These are installed in the machine hall and are equipped with electricity driven IMO pumps, pressure vessels and oil containers.

The hydraulic units are interconnected by pipe lines, and high-pressure oil from any unit can be transferred to any of the three governors. The operating pressure of the system is 19 kg/sq.cm. (270 lb/sq.in).

Turbine Acceptance Tests

The turbines were tested in October 1954. The flow of water was measured with current meters and the power with precision instruments using the 2-wattmeter method.

The results of the tests were satisfactory, as indicated by the adjoining efficiency curve.

LAFORSEN POWER STATION

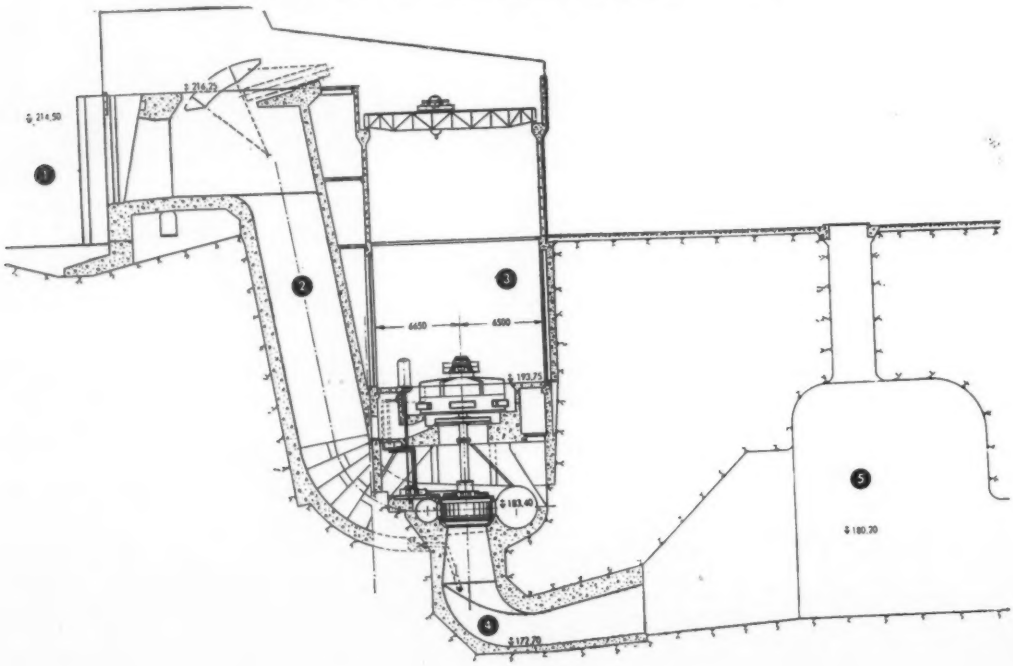
The Laforsen power station lies on the River Ljusnan about 125 miles south of the Storfinnforsen plant. It is owned by Stockholms Superfosfat Fabriks Aktiebolag, Stockholm.

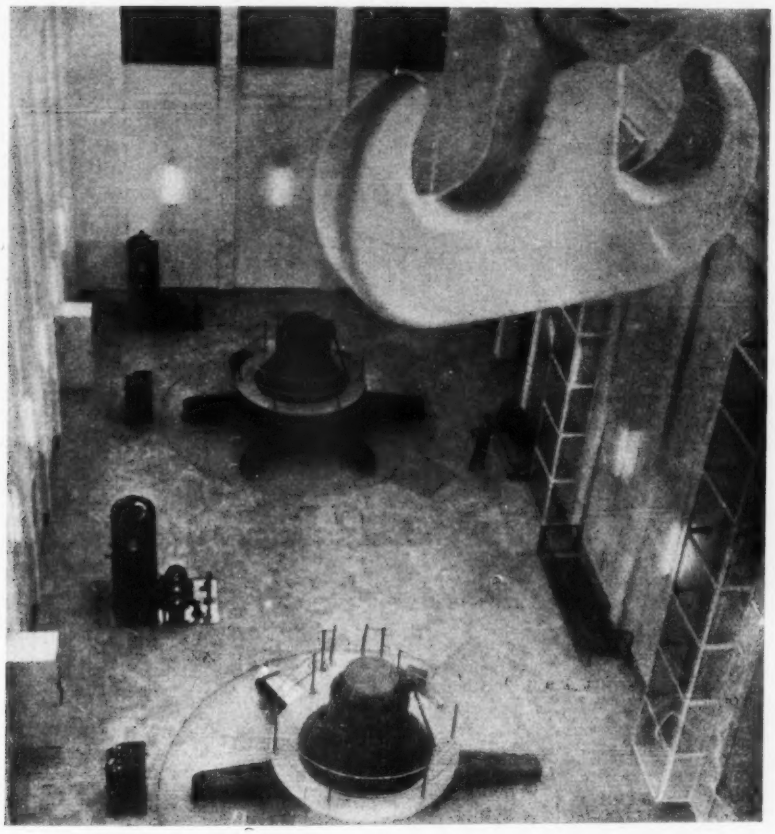
Power Station

This power station is equipped with two vertical *NOHAB* Francis turbines directly coupled to three-phase alternators made by *ASEA*. Each turbine develops 21,500 h.p., operating at 150 r.p.m. under a net head of 34 m. (112 ft.). The rating of each alternator is 21,000 kVA at 11,000 V. The station has been planned for three turbines of equal size, developing a total of 64,500 h.p.

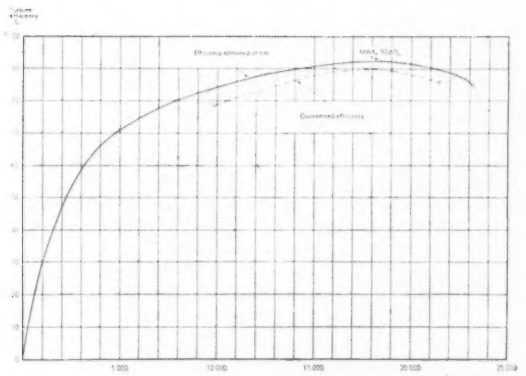
The machine hall and penstocks are excavated from the solid rock. The floor of the machine hall lies about 11 m. (36 ft.) below ground level and 13 m. (43 ft.) above the highest lower water level. The penstocks are lined with steel plate for a distance of 10 m. (33 ft.) from the spiral casing inlet towards the entrance. They are 30 m. (98 ft.) long and have an internal diameter of 5.3 m. (17.4 ft.).

Sectionanl view of the Laforsen plant
1. Intake 2. Penstock 3. Machine hall 4. Draught tube 5. Tail





The Laforsen machine hall. The actuators and pressure oil units are seen to the left.



Turbin Output H. P.

Efficiency diagram for the turbines to the Laforsen power plant. Net head 34 m. (112 ft.) Speed 150 r.p.m.

Supporting Structures for the Generators

The supports for the generators are of unusual design and consist of four concrete brackets resting on the solid rock.

The large amount of space gained underneath the generators simplifies inspection and maintenance of the machinery.

Turbines

These are essentially similar in design to those used in the Storfinnforsen station. The runners have a throat diameter of 2.83 m. (9.35 ft.) and each weighs 13.2 tons. Although the turbines have no special sealing arrangements for the wicket-gates the leakage is only 50 litres/sec. (1.75 cu.ft./sec.) per turbine with the gates closed.

The regulating ring is a steel casting, and is operated by a servo motor connected to it by a link rod. The servo motor is mounted on a base-plate which rests on the stay ring and on the concrete foundation outside the spiral casing.

Governors

Electro-hydraulic governors are used for both turbines. They are of the same type and construction as those used in the Storfinnforsen power station.

Turbine Acceptance Tests

The flow of water was measured with current meters and the power with precision instruments using the 2-wattmeter method. The good results obtained are shown in the efficiency curves.

The test report contains the following conclusion.

(*Continued on page* 23)

Egypt, Sudan and the Nile

The following brief resume of the position of the Nile waters flowing through many countries provides a concrete example of the international complications that are now on the increase in several parts of the world, including the Indus Basin. It will indicate how the nationalist approach is coming in the way of a rational solution and why a regional approach is the only practicable solution.

Egypt has few industries and little rainfall. Her prosperity depends upon the Nile, in using which she has to co-operate with those who control its upper reaches. This dependence is not decreasing. Egypt's population was two and a half-million a century ago, is 20 million now, and is still increasing rapidly. Unless the area of cultivated land is now increased to keep pace with the increase in population her standard of living will decline.

Her ability to achieve this does not depend only upon her ability to distribute water once the Nile has brought it down. If it did, the Delta barrage (which Mohammet Ali built over a century ago in Cairo) and the Asiut, Isna, and Naj-Hamadi irrigation barrage would provide sufficient basis for future development. It depends also upon her success in making herself independent of seasonal variations in the river's natural flow by storing from year to year most of the water that would otherwise run to waste. To store as much water as possible for use when it is wanted, Egypt requires co-operation, not only from the Sudan and Ethiopia but from Uganda and other Governments as well.

In the past it has been recognized that Egypt's interest in using the water is paramount. Many of the States along the Nile or its tributaries gain some benefit from Nile irrigation. But others are—unlike Ethiopia, the Sudan and Egypt—much more interested in it as a source of power. The Anglo-Ethiopian agreement of 1902 safeguards the Sudan's interests in relation to Ethiopia ; the Nile Waters agreement of 1929—between the Egyptian Prime Minister and the British High Commissioner in Cairo, the late Lord Lloyd—safeguards Egypt's in relation to the Sudan. It recognizes Egypt's right to veto works at any point along the Nile if they damage her existing use of water, and precisely limits the amount of water the Sudan can divert for irrigation.

Needs of the Sudan

While British power was dominant in the Nile Valley these arrangements worked smoothly. But the Anglo-Egyptian Sudan has now become the Sudanese Republic. The new rulers in Khartoum are more suspicious of Egypt than their predecessors were, and their desire to safeguard their future right to use more water for irrigation and electrical power has made them question the present division of the waters. Of the average annual flow of 84 milliard tons, 32 are lost and 52 used—four by the Sudan and 48 by Egypt. Before the Sudan co-operates in further reducing the loss, she will want a larger proportion of the water that is saved. She may also want it understood that where Egypt can regulate the flow of water by means which help irrigation and power projects in the Sudan, these means should be preferred to others.

The Ethiopian tributaries—the Sobat, the Atbara, and the Blue Nile (from Lake Tana)—provide six-sevenths of the Nile's annual discharge, but their flow is irregular. The Ethiopian rains begin in March or April and by August or September the rivers are in in full flood. But the flood then falls rapidly, shrinking to 8% of the river's flood discharge just before the rains begin. Though one of them—the Sobat—runs into the While Nile, the White Nile is extremely regular compared with the Blue Nile and the Atbara. It has behind it the vast natural reservoir of the Great Lakes. At its lowest it is seldom lower than half its spate, and when the main Nile in Egypt is driest it provides fourfifths of its water.

Egypt's problems are, therefore to store the waters from Ethiopia when the floods rise and to release them gradually when they are over ; to reduce the flow of the White Nile when the Blue Nile is in flood, and to prevent the loss of water by evaportion and flooding at all points along its course. To do this, detailed observation of the habits of the river and most of its tributaries is necessary, as well as large and expensive regulating and "over year storage" dams at crucial points along it.

Before 1949 Egypt's needs were met by building inside Egypt and the Sudan. But neither the original Aswan Dam (completed inside Egyptian territory in 1902 and raised in 1912 and 1934) nor the Jebel Aulia Dam (built in 1937 on the White Nile south of Khartoum to hold back the White Nile when the Blue was in flood) was big enough. The Sennar Dam on the Blue Nile is a predominantly Sudanese irrigation project (for Gezirah cotton) ; and the proposal to turn Lake Tana into a large artificial reservoir was abandoned when the Abyssinian war broke out. Since 1949 it has been agreed that more extensive projects are needed, and over the past seven years the British, Uganda, Sudanese, Ethiopian, and Egyptian Governments—and the World Bank—have spent much time discussing what form they should take.

Competing Schemes

These discussions have not been conclusive because the competing merits of the two plans that were considered became more controversial as Egypt's relations with the Sudan got worse. The first plan was intended over 20 years to control the river's flow from the Sudan or south of it. Apart from extending the Lake Tana scheme, it involved building a wide diversion channel to carry the river around the Sudd marshes to Jonglei, regulating dams at Lakes Kioga and Albert (to control the White Nile when the Blue floods), a regulating and irrigation dam at Roseires to Blue Nile, a flood protection barrage at Merowe ; and at Jinja, where Lake Victoria pours over the Owen Falls, a hydro-electric station for Uganda and the

Belgian Congo and a dam to raise the lake's storage capacity. The last two were the only projects actually started ; the dam, when it was completed in 1954, made Lake Victoria the largest reservoir in the world.

The second plan involves building a new high dam at Aswan, flooding 150 miles of the Nile in the Sudan and 300 in Egypt, rehousing 40,000 or 50,000 Sudanese inhabitants, and submerging the Sudanese town of Wadi Halfa.

The advantage of the first plan—which many of the Governments supported in 1949—is that it would increase the area of the Sudan's irrigated land by draining the Sudd marshes and providing new irrgations dams where the Sudanese Government would like to have them. The Sudan finds the plan attractive because, while it recognizes that Egypt—who would bear most of the cost—has the major interest in the Nile, it effectively reconciles her interests with those of the Sudan. Egypt, however, objects because it distributes through a number of works control that could otherwise be concentrated in one large dam, and because it places Egypt too much at the mercy of the upstream Governments.

Aswan Dam Project

The second plan was proposed by the Egyptian Government last year. It is open to technical objection on the ground that Aswan is at the hottest point of the Nile, where evaporation will be great, and on political grounds because it will deprive the Sudan of many of the irrigation benefits she would gain from the first plan. The Aswan Dam will provide electrical power and irrigation water, but in the Nubian desert, where the Sudan could not easily use them.

The World Bank, which will provide much of the money, has approved in principle the construction of the Aswan Dam. But it has made its practical support provisional on Egypt's reaching agreement about the Sudan's future share of the Nile waters and about the compensation the Sudan will get for the inconvenience her population will suffer.

Either plan would probably bring into use 10 or 20 milliard tons of water a year more than are used at present. The high dam at Aswan could probably do this slightly more effectively, and the Sudanese Government might be induced to accept it inside its territory if money were provided separately for irrigation and power projects at Roseires and elswehere. But unless during the negotiations that are going on now Egypt does more to satisfy the Sudan it is difficult to see how any plan can be put into operation. (*From The Times, London.*)

NILE VALLEY AUTHORITY SUGGESTED

A member of the British Parliament claimed that "a violent conflict" loomed ahead over the next generation for use of the waters of the River Nile.

Mr Hugh Fraser (Con) opened a debate in the House of Commons calling for the establishment of a Nile Valley Authority.

By the end of this century, he said the Nile irrigation would help feeding between 70 million and 80 million people. Only such an authority as he proposed could avoid the tension which might grow between the peoples inhabiting the Nile Valley.

Mr Fraser attacked Egypt's giant Aswan Dam project for controlling the Nile. He claimed under this scheme Egypt would be using waters contrary to the interests of the people in British East Africa.

Mr Richard Stokes, a former Labour Minister, agreed with the idea of a Nile Valley Authority saying he was "speaking as a great friend of Egypt who supported Colonel Nasser, the Prime Minister, in what he had done for the "underdog" in Egypt.

A multi-purpose dam scheme would be better for Egypt than the Aswan Dam project, which with the arrival of nuclear energy projects, might well become old-fashioned.

Mr Julian Amery (Con) urged the Government to withdraw support from the Aswan Dam project and to influence the U.S.A. to do the same.

"It should be made clear that the whole question can only be discussed again if Egypt changes her tune with due regard to her own people and peace in the Middle East," he said.

(*Continued from page* 21)

Storfinnforsen and Laforsen Power Stations

'The turbines fully attain the guaranteed maximum power and efficiency. The governors fully satisfy the guarantees regarding maximum frequency rise on switching off.

"The turbine installation gave excellent performance in general and proved to have been erected with great accuracy, and we therefore recommend acceptance of the plant delivered."

The report is dated March 2, 1954 and signed by Birger Norsell and Mgnus Hartwig, engineers from Vattenbyggnadsbyran (Consulting Engineers and Architects.)

Draft Standard Specification for Distribution Transformers

The Indian Standards Institution has recently put into circulation for critical review and comments the draft of a specification for outdoor type distribution transformers up to 100 KVA, 11 KV.

For some years the Institution has had under consideration the project for the formulation of an Indian Standard covering the range of transformers produced in the country. The present annual output of this industry is estimated at Rs. 3 crores and this figure should double itself by the end of second five year plan. Purchase and manufacture of transformer in the country has in the past been guided in part by the practices and standards followed abroad. At the level of the International Electrotechnical Commission work on the formulation of an IEC recommendation for power transformers has been progressing but the work at that level is, understandably, not quite detailed in so far as certain design and constructional features are concerned. Also at the national level the problem is somewhat different, and a more comprehensive answer is called for. The The progress of the many power projects in the country has resulted in a very great demand for distribution transformers, including transformers intended for tubewell purposes and a very large proportion of the present demand is in the distribution range of 100 kVA, 11 kV. These are ordered mostly by Government Departments and public authorities concerned with electrical distribution. The demand is made in a large number of sizes and the voltages specified also vary by small amounts. Similarly, there are a number of other variations in the purchase specifications. The result is that the manufacturer has to be prepared to supply transformers to meet not only a number of different electrical characteristics but also constructional features. Fortunately, however, in the manufacturing and user circles there has been increasing appreciation of the existing position and this has led to the formulation of the draft Standard. The committee responsible for the preparation of the draft consists of Indian manufacturers, importers with manufactories in India, representatives of Government Departments, Railways, Central Water and Power Commission and the electricity supply industry.

Some of the benefits which are expected to accrue from the acceptance of this Standard are :

(1) Interchangeability of complete transformers of same rating, thus saving time and expense in the case of breakdown or when transformers are taken down for servicing.
(2) Easy and economical replacement of accessories, such as bushings, terminal arrangements, etc.
(3) Reduction in the number of spare transformers and spare-parts, thus resulting in economy of capital cost.
(4) Better parallel operation of transformers of different makes.
(5) Quicker deliveries as a result of rationalization of types and sizes, and partly as a result of the possibility of manufactureers building up stocks of transformers and constructional parts.
(6) Improved manufacturing efficiency owing to larges production of transformers and of parts made by outside suppliers.
(7) Reduction in the cost to the purchaser as a result of simplification of design details and constructional features and avoidance of fittings other than those really necessary.

The draft Specification recognizes three standard voltage ratios, viz., 3.3 kV/416 V and 6·6 kV/416 V, 11 kV/416 V and the standard sizes specified are : 15, 25, 50, 75 and 100 kVA.

Distribution transformers are being employed in some cases for tubewell purposes as well, but the use of transformers specially designed for this application is also popular in some parts of the country. The Standard therefore distinguishes, wherever necessary, the special features for such transformers as distinct from general distribution transformers.

The operating temperatures in India are higher than those encountered in temperate countries. Experience in this country with 11 kV transformers indicates that the provision of conservators on transformers for certain voltages and capacities would be justified. Similarly, the fitting of arcing horns has been found very desirable for providing extra protection to the windings. The draft Standard, therefore, has made it obligatory that distribution transformers for 11 kV and transformers of capacities higher than 50 kVA should be fitted with conservators, and that arcing horns should be provided on transformers for all voltages and capacities.

Fittings naturally form an appreciable part of the cost of a transformer and the draft Standard lays down the necessary minimum items of fittings to be provided on distribution transformers and transformers for tubewell purposes. A list of extra fittings which could be supplied at the option of the purchaser has also been given.

At present practically the entire demand for transformer bushings is met by imports but it is hoped that very soon these bushings would be made in India and the need to import will not be there. Transformers are now being fitted with bushings of different design, dimensions, fixing arrangements and electrical characteristics with the result that interchangeability isnot conveniently possible. A very important feature of this draft Standard is the standardization of the dimensions, design and electrical characteristics of one type of HV bushing and another type of LV bushing for the whole range of transformers covered by the specification. This should considerably facilitate manufacture of bushings quite economically. The design of the HV bushing put forward in the draft would also enable its replacement without having to remove the cover of the transformer tank.

Editorial

A Scheme of Zonal Authorities

We are very glad to find that the Interim Report of the River Valley Projects Technical PersonnelCommittee, of which Sri. W. X. Mascarenhas is the Chairman, strongly recommended the establishment of Zonal Authorities for integrated development of river basins in our country. This is a point of view which we have been stressing for a very long time and more particularly in our Memorandum to the DVC Enquiry Committee. We have criticised the River Boards Bill as recently as April 1956 in these columns from the same angle. Now that an important Committee appointed by the Government of India has come to accept a similar approach to this major problem as ourselves, we request the Government at the Centre and in the States to reorientate their attitude in this direction and perspective as early as possible or, alternatively to state their point of view for public consideration. We take the liberty of quoting below in full the relevant portions of the Report for wider understanding:

* * *

We have assumed, in sketching the All-India picture of technical personnel requirements for River Valley Projects included in the Second Five-Year Plan and in making our proposals as to how they are to be met, that it is possible to equate surpluses in any one area or Project Formation with the deficits in other areas or Project Formations. In point of fact this assumption would be justified only if there were complete accord and cooperation in this regard between different areas and Project Authorities, and further if there were complete and unrestricted mobility of technical personnel in any desired direction. In the interests of economy and the most fruitful deployment of our technical personnel, projects would also have to be phased to allow a continuous and orderly movement of various kinds of technical talent and experience from project to project as required. Unfortunately, these ideal conditions simply do not exist ; on the contrary *each State tends to function as if it were working in isolation from its neighbours,* and the only coordination and cooperation between States is that enforced on them in the process of exploiting common water resources ; the States then come together, or, more often, are brought together by the good offices of the Centre, for the purpose of constructing works of mutual benefit. But there is *generally speaking no coordination at the Planning stage, and the phasing of projects as such is never considered.* We, therefore, feel that for the optimum use of our limited resources in technical personnel and experience, the first thing that needs to be done is to *build up planning and construction organizations for River Valley Projects on a comprehensive and rationalised basis.* (*italics ours*)

Projects undertaken by individual States in isolation and for limited or unrelated purposes as they are, by and large, at present, are not always or necessarily in the best interests of the country as a whole, and for the optimum development of our water resources on a comprehensive, long term basis, planning as well as execution of our River Valley Project should, as their very name implies, be *related to a complete river valley or basin* as far as possible, the competing claims of the different basins being woven into a coordination pattern of national development by the Central Government to an approved order of priorities based on technical, economic, sociological and political considerations.

It would clearly be in the interests of the States and the Centre, if both cooperated in setting up a well-planned organisation or organisations, specially created and streamlined for achieving the targets of the country as a whole as well as its component units, *as naturally demarcated by the great river systems.*

Three alternative types of organization could conceivably meet our requirements :—

(*a*) A central Organisation charged with the responsibility of planning and executing the projects all over the country.
(*b*) An independent organisation or organizations set up in each State to deal with those projects or parts of projects that directly concern the State.
(*c*) Zonal Organizations, the country being demarcated for the purpose into five, or more zones, each zone covering one or more complete river basins, as far as possible.

As regards (*a*) it is becoming increasingly apparent that a vast country like India with so many soil-climate complexes and types of irrigation practice could not be covered by a single authority with the desired degree of efficiency and economy. Moreover, the States would almost certainly be unwilling to subordinate themselves completely to such a single authority, that not merely advises but plans and executes all projects. They would always claim that they had special problems peculiar to their areas, into which they had a better insight than any Central Authority, and that local talent and patriotism could be better geared to local development through their own agency. Already the CW & PC no longer undertakes the execution of projects, except such as are specially entrusted to it by the States themselves. In any case in order to meet the needs of the whole country fully, a Central Organization would have to be so large that it would inevitably become unwieldy and inelastic, and thus forfeit most of the advantages accruing from centralization.

As regards (*b*) viz. an independent organization in each State, the difficulty is that the organization would have to cooperate with its opposite number in other States much more closely than there is any evidence of at present, if there is to be an integrated basin-wise development. The inevitable clashes over the division

of available flows from the basin could no doubt be resolved by the usual methods, but the possibility of having a common canal would be almost certainly overlooked, with each State thinking in terms of its own boundaries and its own exclusive requirements. Moreover as each State would normally employ only persons possessing its own domicile, not only would the planning and administrative staff be considerably larger than under a system of regional development but also the movement of executive and work-charged personnel and of construction plant and equipment from project to project, irrespective of State boundaries would be greatly impeded, if not altogether blocked. Thus, on all counts *independent State organisations would be wasteful* of men and money, and might even be wasteful of time, a commodity of great value if we consider the country's ambitious programme. Finally, the smaller States might not possess the resources in men and experience to make any headway at all with their schemes, even though these schemes were given high priority in the All-India Programmes.

As regards (3) viz. Zonal Organisations, workable zones might be as under :

(*a*) North-West Zone—Covering the tributaries of the Indus flowing through this country.

(*b*) North-East Zone—Covering the Ganges and Brahmaputra Valleys, but excluding the tributaries of these rivers falling in (*c*) and (*d*) below :

(*c*) West Central Zone—Covering the rivers in the Western half of Central India, e.g. Chambal, Banas, etc.

(*d*) East-Central Zone—Covering the rivers in the Eastern part of Central India e.g. Mahanadi etc.

(*e*) South Zone—Covering the valleys in the peninsular part of the country, e.g. Narmada, Tapti, Godavari, Krishna, Cauvery, the coastal river valleys, etc.

(The above list is purely illustrative and could of course be modified as required).

Each Zone might again be sub-divided into regions, each region covering a separate river or its important tributaries. The States having a direct concern, jointly and severally with these zones, should co-operate to set up some form of Development Authority for each zone. Development Authorities should be constituted under an Act of Parliament, and the members of the board should be appointed by the Centre in consultation with the States concerned and comprise officials and non-officials drawn from these States and r presentatives of the Centre. The board would then appoint its administrative and executive officers, as a rule, from amongst the State Cadres. Details will have to be carefully worked out, but the legitimate interests of each State would have to be safeguarded in this regard. The Development Authority's officers would plan and execute all river valley projects and flood-control works within the zone according to an agreed, continuous and phased programme, thus securing a better utilization of experienced personnel and also of the construction plant employed by moving both from project to project. The Development Authority's officers could revert to their parent States after a reasonable tenure of office with it and be replaced by fresh incumbents drawn from the State Cadres. This two-way flow of officers from the States to the Development Authority and from the Development Authority back to the States would ensure fresh blood and local experience always being available to the development Authority, and the experience and broad outlook obtained with the Development Authority being in turn available to the States. Moreover, the great difficulty now experienced by existing Central Organizations, such as the CW & PC in getting the States to spare officers possessing ability, initiative and drive for service with themselves would disappear, since the States would have a direct interest and stake in the working of the Development Authorities, as all important projects in the constituent States would be planned and executed by the Development Authority concerned. The mobility of the lower category of technical personnel such as Overseers, Technical Assistants, Mechanics, Tractor Operators, etc, would also be better ensured within a zone since, generally speaking, conditions of work would be uniformed in the zone and the men would not have to go very far from home. It is necessary to emphasise that the Zonal Authorities would be concerned only with the planning and execution of projects and that the the management of the works after completion would vest in the States concerned, except where joint management was separately and specifically provided for by mutual consent in respect of common works. Further, a single, State if large enough, could comprise a whole zone ; on the other hand, a single State might participate in more than one zone.

The present pattern of organization appears to be some sort of combination of the first two types with CW & PC undertaking only a limited liability for basic planning and construction and the States undertaking the rest, with the ad hoc Corporations or Control Boards specially constituted by the Centre for some special projects and apparently not faring too well in their relations with the States concerned. The third type of organisation would, therefore, appear to afford the best means of securing that vital element in all development plans, the close co-operation of the States affected, because it strikes the correct balance between local patriotism and the national interest.

But even if Zonal Development Authorities are established, the Ministry of Irrigation and Power would nevertheless need a Central Organisation to co-ordinate their work, but the functions of such an organization would be confined largely to advising the Ministry in regard to the settlement of disputes between the Constituent States of the Zones, to the collection of technical and hydrological data, etc, supplied by the Zonal Authorities and States and their dissemination throughout the country; affording technical advice or assistance to any State or Development Authority seeking it ; and scrutinising zonal projects for the purpose of helping the Planning Commission in determining, which should be included in the successive plans and afforded financial assistance by way of loans : reviewing their progress etc.

Incidentally, this set-up would have the further advantage of enabling the Centre to allot funds on a

(*Continued on page* 16)

Letters to the Editor

I

DEAR SIR,

Over 3 years have elapsed since a letter was published in the November 1952 issue of your Journal, pointing out that flumes (mentioned in a statement of deep cuts or tunnels below the letter) on certain canals included in the First Five Year Plan would not be able to carry the discharge for which they were designed. It was made clear that the deficiency will be considerable—(about 40%.)

It was then hoped that demand for irrigation water will be in accordance with the expectations in the Plan and that the flumes referred to will be automatically tested before long. Unfortunately, the actual demand for irrigation is much slower and the discharge passing through most of the flumes referred to much smaller. Owing to these and other reasons the flumes could not get tested automatically as expected. Special efforts made to test the flumes for their carrying capacity also failed owing to various reasons.

In the meantime some more cases of flumes which are also destined to fail to carry the discharge for which they were designed, have come to notice.

Some more time is essential to collect data from flumes already constructed to allow the defects inherent in the existing procedure to be published. The same when published will show that flumes throttled down beyond a certain limit will fail to carry the discharge indicated by the normal procedure of designing on the basis of Kutter's or Manning's formula. The main difficulty in obtaining data is the great unwillingness on the part of a majority in charge of such flumes to provide the figures required or to allow observations to be made, for one reason or another. In some cases, there have been genuine difficulties ; in the case of others, the development of irrigation is much slower, the discharge being sent down the flumes being thereby much smaller than the minimum essential. In some cases, there is no dependable measuring device ; in other cases there has been reticence. In some cases at least there has been a definite refusal to supply data required ; the tone indicates that the authorities consider that they were fully alive to the requirements and that outsiders need not worry in the matter. Only a couple of cases indicate that data was likely to be available after sometime.

In the meantime more cases (some involving very intense throttling) of flumes have come to notice. It can be proved beyond doubt that the designed depth of water will be far exceeded if the designed discharge was sent down the flume—thereby making conditions dangerous. In the case of a certain very large capacity canal, the discharge will not be able to pass as the depth of water can be raised to a limited extent only.

This letter is being published mainly with a view pointing out that every effort was made to give a timely warning and if authorities in charge do not take notice, in spite of that (warning), it will be regrettable. It is possible that some will fail to put their faith in the predictions, so long as they are not supported by the defects in the prevalent procedure being explained and till the same were scrutinized and criticised by Hydraulicians. The reply to that objection is that the writer finds himself on the horns of a dilemma. If he publishes an explanation of the defects *now*, it will be dubbed as untenable as there was not sufficient data for recently designed channels in support. If the publication was delayed, many flumes, will, in the meantime, have been constructed to the detriment of the nation. The example of the Old Nira Right Bank Canal has already been published. The writer therefore appeals once more to all Hydraulicians in India and outside, that they should help in supplying data by making special efforts and by cooperating with the author in the matter.

This is not a case which will affect only one canal or one State. This question is not restricted to one nation (India) either. It is a problem of international importance.

April 9, 1956

Yours faithfully,
FLUME

II

SIR,

In February, 1956, issue of Indian Journal of Power and River Valley Development, under head "Our Delhi Letter", I read with concern, the damaging news regarding the alleged damage to Khatima Power House. I have personally inspected the power-house since, and I am writing this because Sarda Power House, as I call it, stands intact. There had been neither any failure of the structure, nor any subsidence. What actually happened was a slight settlement of the earth-filling behind a pervious downstream wing wall, resulting in a non-consequential crack in the small station service transformer shed, adjacent to the Control Room Block. This occured in September 1955, when the operation of the Power-house was held up due to a defect discovered during trial running, in the under-water bearings of the power-plant, supplied and erected by M/s English Electric Co. Ltd. Closure of the Power-house on that account somehow got sensationally and incorrectly alluded to the settlement in the earth filling, which occured at a place well beyond the machinehouse itself. So far as the building of the Power-house was concerned, there was nothing to prevent the Power-house operating at any time. The defect in the bearings too since has been rectified and the Power-station is in full operation.

The news, unfortunately purported to give a wrong impression that there had been a major damage to the biggest hydro-electric Power-station in Uttar Pradesh. Nothing could be farther from truth than such an impression. Sarda Power House, as I know it, (having been the Construction Engineer-in-Charge from its foundation to almost its finish, viz ; for a period of 6 years) is, in itself, a feat of Foundation Engineering. Its foundation raft measuring roughly 100 feet by 200 feet built in monolithic heavy reinforced concrete and encased within a 40 feet deep

iron curtain type Coffer Dam, rests at a depth of almost 100 feet below the ground-level of the area and about 67 feet below the normal sub-soil water table. Unusually difficult foundation conditions and unprecedented problems of foundation drainage were encountered in its construction Extra precautions and care had been taken to avoid ill-effects of unequal settlement, if it ever took-place. The Power-station built in about 20 lakh cubic feet of cement concrete and masonry therefore, consists of seven main structures ; viz ; (i) the forebay and in-take gate structure, (ii) the Penstock R. C. C. Ducts, (iii) the erection bay, (iv) the main Machine-house, (v) the Control Room block, (vi) the tail-race works, and (vii) the out-door sub-station.

All these have been founded almost independently, with adequate flexible copper seal jointing, according as needed to safeguard against many a complex hydraulic influence and pressure. None of these main structures has been affected in any way by the slight settlement of earth filling behind the wing wall.

How and why the settlement in earth filling took-place may also need probed into. Such settlement in deep filling not being unusual, had, in fact, been anticipated. And, dewatering of the downstream trough without first adequately lowering the sub-soil water-table was accordingly forbidden. Unfortunately, on account of the defects in the under-water bearings of the machine, dewatering of the tail-race was sought towards the end of monsoon period in September 1955, when the sub-soil supplies are heaviest. The tail-race work, which had otherwise been built very judiciously, were subjected to unusual service conditions, which they were not designed for, and as a result of such severe dewatering, soil particles from behind the pervious wing wall appeared to have flowed into the tail-race. Signs of settlement in the earth filling were noticeable soon after, and water level in the tail-race was restored to R.L. 634 i.e. to about 11 feet below the bed-level of the downstream channel at R.L. 645, and further settlement was obviated. Some more precautionary measures have, however, been taken to safeguard against any further erroneous action of this nature.

As the news item tends to unnecessarily slur the reputation of a work, so painstakingly executed, in so unprecedented difficult conditions of site and circumstances and so laboriously planned out as to make the so-called impossible possible, it shall provide comfort to many a compatriot in our line, if you will kindly publish this letter in your esteemed Journal, particularly in clarification of your note under "Our Delhi Letter" referred to above.

Yours faithfully,

Delhi, May, 22, 1956

BALESHWAR NATH

ALL-INDIA CADRE OF ENGINEERS URGED

The Engineering Personnel Committee of the Planning Commission has emphasised the need to raise the standard of engineering education and recommended the creation of an all-Indian cadre.

In its report it says : "The strength and effectiveness of our future development will depend, to a large extent, on the quality of engineering personnel available for absorption. No efforts should, therefore, be spared in achieving a high level of competence in engineers who will be trained by various methods during the coming years."

The Committee says that in 1960-61, India will be in short supply of engineering personnel to the extent of 1,800 graduates and 8,000 diploma holders in different branches. It feels that if the existing institutions are expanded fully, it may be possible to secure on an average a 20% increase in the outturn of graduates and 25% in the case of diploma holders. The total cost of creating additional training facilities will be in the neighbourhood of Rs. 16 crores.

Another important recommendation of the Committee is a phased programme in regard to Government's orders for machinery from foreign countries. Such a programme, according to the Committee, will be helpful for stepping up internal production and for widening the scope of apprenticeship in the engineering trade. The Committee has further emphasised the need for utilising all training opportunities offered by foreign consultants and suppliers of machinery. The Committee recommends that when foreign consultants are engaged by the Goverment of India these consultants should train Indian technicians to meet not only the needs of the single plant but also those of similar plants, programmes for the establishment of which are in sight.

Recommending the creation of an all-Iindia cadre, it has suggested that the States should agree to a common line of action with a view to offering uniform conditions of service for persons engaged on developmental schemes. With this in view, the Committee has suggested the creation of a suitable authority by agreement between the States and the Centre for regulation of salary scales and security of tenure, and allocation, inter-State movement and welfare of personnel engaged on development projects outside the regular cadre.

CORRECTION

In the contribution entitled "Construction Corporation for River Valley Projects" by Sri. Kanwar Sain, the para on 'Suggestions for setting up a Construction Corporation refers to "Hirakud" at several places. It should read "Bhakra". The article is based on a Paper read by the author at the Engineers' Seminar held at Srinagar.

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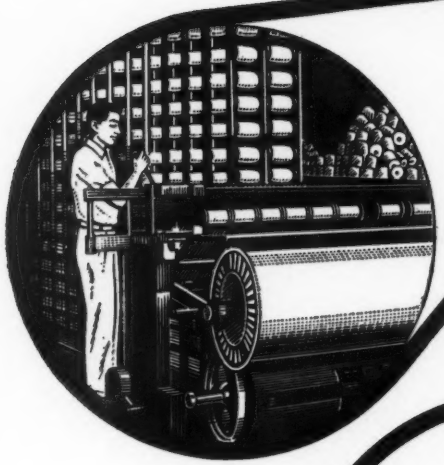

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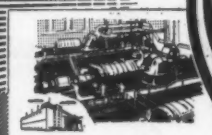

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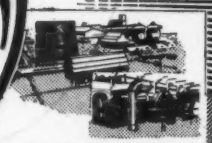

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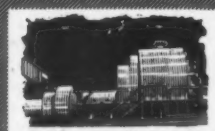

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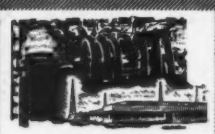

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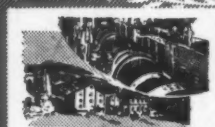

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